# UNIVERSITY OF PENNSYLVANIA

## THE WHARTON SCHOOL

## FNCE 102

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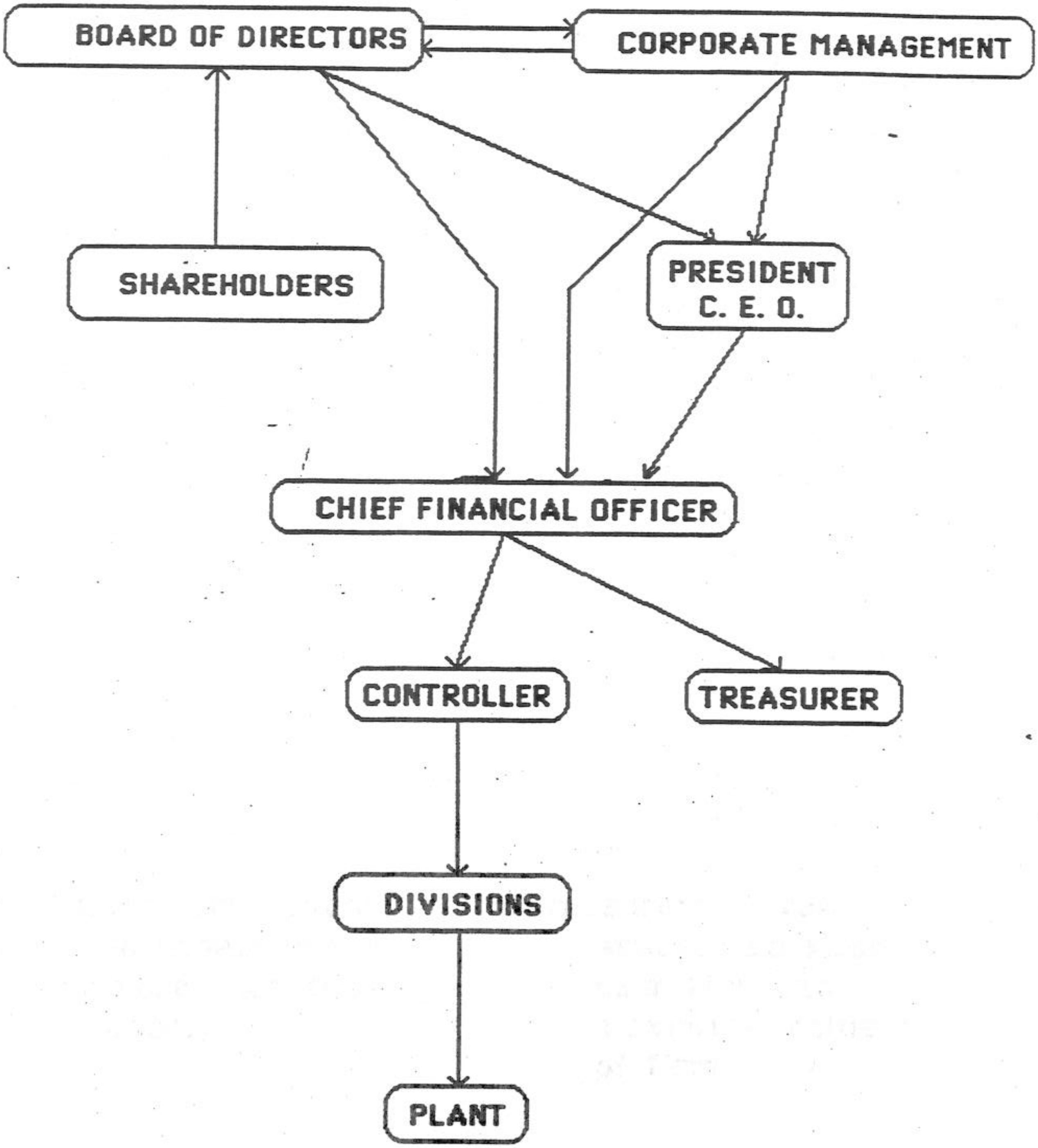
WHARTON REPROGRAPHICS

# OVERVIEW

# FINANCIAL DECISION-MAKING IN THE FIRM



## CONTROLLER VS TREASURER

Corporate balance sheet (market values):

| Assets: | Liabilities: |
|---|---|
| tangible<br>intangible | equity<br>debt<br>hybrid |
| Total Value of Assets | Total Value to Investors: |

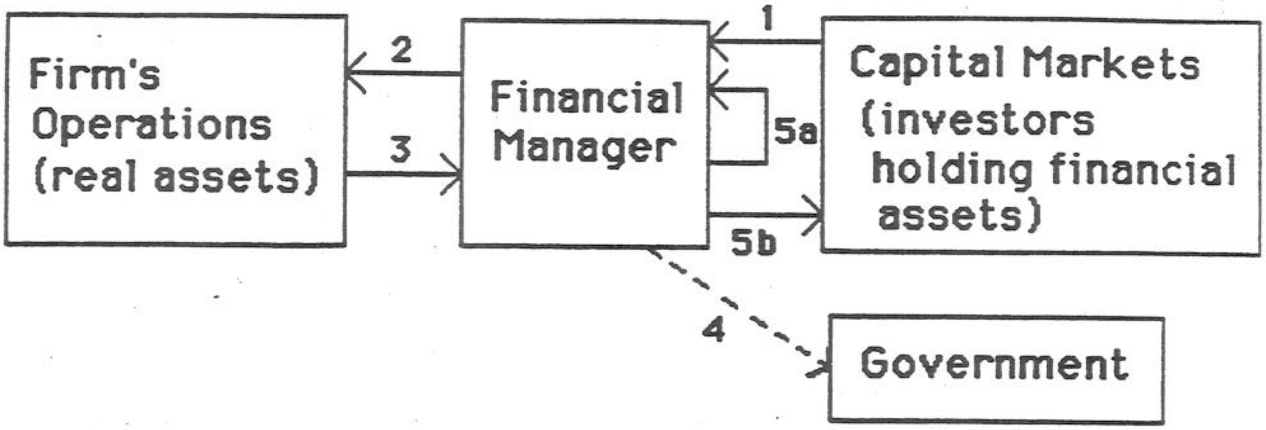
this side determines the size of the pie

this side determines how it is sliced up (in value and risk)

**Controller:** Invest in assets worth more than they cost.

**Treasurer:** Given assets, package cash flows to maximize value of firm.

# OVERVIEW OF CORPORATE FINANCE


Firm's Operations (real assets)
Financial Manager
Capital Markets (investors holding financial assets)
Government
1
2
3
4
5a
5b

1. Firm borrows privately (bank) or issues securities to raise capital (FINANCING DECISION).

2. Firm invests in real assets (CAPITAL BUDGETING DECISION).

3. Firm's operations generate cash flow.

4. Taxes computed and paid.

5. a. Retained earnings are reinvested;

   b. Cash paid out to investors (e.g., DIVIDENDS and INTEREST).

WHARTON REPROGRAPHICS

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# FUTURE AND PRESENT VALUE

# CAPITAL BUDGETING

How do—and how should—firms decide which assets to buy.

1. FUNDAMENTAL CRITERION:

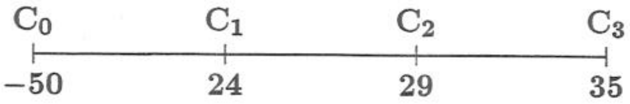
   Buy assets with value which exceeds asset cost.

2. FIRST OBSTACLE:

   Value depends on future cash flows generated by capital asset. But value of these cash flows will depend on their size, timing, and risk.

   Example:

   Purchase machine in 1995 which generates cash flows in each of the next 3 years:



3. OBJECTIVE:

   To put cash flows occurring at different times and of different degrees of riskiness on comparable basis.

# MECHANICS OF COMPOUNDING AND DISCOUNTING

## COMPOUNDING -- FUTURE VALUE (FV):

Invest $1 today for 1 year at interest rate r.

$FV = \$1\,(1 + r)$

e.g. $r = 10\% \Rightarrow FV = \$1.10$
$r = 15\% \Rightarrow FV = \$1.15$

- Risk: U.S. government security vs. Eastern Airlines bond
- Alternative view: investor indifference between $1 today and FV in 1 year

$FV = \$C\,(1 + r)$

# MECHANICS OF COMPOUNDING AND DISCOUNTING

## DISCOUNTING – PRESENT VALUE (PV):

**Receive $1 in 1 year at interest rate r.**

| | |
|---|---|
| *Ask:* | what amount must be set aside today (PV) to have $1 in 1 year at the return r? |
| *Answer:* | $PV\ (1 + r) = \$1$ |
| *Therefore,* | $PV = \frac{\$1}{1 + r}$ |
| e.g. | $r = 10\%$ => $PV = .91$<br>$r = 15\%$ => $PV = .87$ |

- The role of risk
- Investor indifference and market salability

$$PV = \frac{\$C}{1 + r}$$

# CALCULATING THE EAY GIVEN THE APR

**APR = 10%** **Invest $1 for 1 year**

| Frequency of Compounding | Amount at Yearend | EAY |
|---|---|---|
| 1 | $(1 + .1/1)^1 = 1.10$ | .10 |
| 2 | $(1 + .1/2)^2 = 1.1025$ | .1025 |
| 4 | $(1 + .1/4)^4 = 1.1038$ | .1038 |
| 12 | $(1 + .1/12)^{12} = 1.1047$ | .1047 |
| 360 | $(1 + .1/360)^{360} = 1.1051$ | .1051 |
| continuous | $e^{.1} = 1.1052$ | .1052 |

## EXAMPLE

**Invest $1 for T years if APR compounded n times per year:**

**e.g.,**

**Certificate of deposit**
**APR = 10%, compounded quarterly**
**holding period = 2 years**

**At end year 1 :** $(1 + .1/4)^4$

|--> $(1 + .1/4)^5$ **at end 15 months**

|--> $(1 + .1/4)^6$ **etc.**

|--> $(1 + .1/4)^8$ **at end 2 years**

**In general,**

$$FV = (1 + APR/n)^{nT} = (1 + EAY)^T$$

**Continuous compounding**

$$FV = \lim_{n \to \infty} [(1 + APR/n)^n]^T = e^{(APR)T}$$

## INVESTMENT OPTIONS – AN EXAMPLE

Want to invest $1000 for 5 years.

Option (a): APR = 11%, compounded quarterly plus immediate cash bonus of $25

Option (b): Continuously compounded APR

*Question:* At what APR do you prefer (b)?

*Solution:* Under (a), have at the end of 5 years:

$1025\,(1 + .11/4)^{4x5} = 1763.44$

With (b), at end of 5 years have:

$1000e^{5(APR)}$

Therefore, investor indifferent if:

$1000e^{5(APR)} = 1763.44$

$e^{5(APR)} = 1.76$

$5(APR) = .5673$ (natural log)

$APR = .1135$

## MULTI-PERIOD VALUATION

**Earlier example:** $C_1 \quad C_2 \quad C_3$

$$PV = \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3}$$

**Net present value (NPV): compare PV to $C_0$**

## SHORTCUTS FOR MULTI-PERIOD PROJECTS

**PERPETUITY:** $\underset{C}{C_1} \quad \underset{C}{C_2} \quad \underset{C}{C_3} \quad \underset{C}{C_4}$

Examples: U.K. Consol, equity with flat dividend

Valuation: $P = \frac{C}{1+r} + \frac{C}{(1+r)^2} + \frac{C}{(1+r)^3} + \ldots$

OR $P = \frac{C}{r}$

e.g., consol paying $100/year:

$r = .10 \Rightarrow P = \frac{100}{.1} = \$1000$

$r = .09 \Rightarrow P = \frac{100}{.09} = \$1111$

**GROWING PERPETUITY:** $\underset{C}{C_1} \quad \underset{C(1+g)}{C_2} \quad \underset{C(1+g)^2}{C_3} \quad \underset{C(1+g)^3}{C_4} \ldots$

Valuation: $P = \frac{C}{1+r} + \frac{C(1+g)}{(1+r)^2} + \frac{C(1+g)^2}{(1+r)^3} + \ldots$

OR $P = \frac{C}{r-g}$ if $r > g$

e.g., equity with initial dividend (occurring at end of year 1) of $100 growing annually at rate of 3%:

$r = .10 \Rightarrow P = \frac{100}{.1 - .03} = \$1428.57$

$r = .13 \Rightarrow P = \frac{100}{.13 - .03} = \$1000$

**ANNUITY:**

$$\begin{array}{cccccc} C_1 & C_2 & C_3 & \cdots & C_T \\ \hline C & C & C & & C \end{array}$$

**Examples:** conventional mortgage, pension contributions

$$P = \frac{C}{1+r} + \frac{C}{(1+r)^2} + \frac{C}{(1+r)^3} + \cdots + \frac{C}{(1+r)^T}$$

**Valuation as difference of perpetuities:**

| | $C_1$ | $C_2$ | $C_3 \ldots$ | $C_T$ | \| | $C_{T+1}$ | $C_{T+2} \cdots$ |
|---|---|---|---|---|---|---|---|
| Perpetuity 1 | C | C | C ... | C | \| | C | C |
| Perpetuity 2 | | | | | \| | C | C |

$P_{ann} = P_1 - P_2$

$P_1$ (as of beginning of period 1) $= \frac{C}{r}$

$P_2$ (as of beginning of period T+1, or end of period T) $= \frac{C}{r}$

$\Rightarrow$ $P_2$ (as of beginning of period 1) $= \frac{1}{(1+r)^T}\ \frac{C}{r}$

$$\Rightarrow P_{ann} = \frac{C}{r} - \frac{1}{(1+r)^T}\ \frac{C}{r} = C\left\{\frac{1}{r}\left[1 - \frac{1}{(1+r)^T}\right]\right\}$$

e.g., C = \$100 T = 3 years

$$r = .1 \Rightarrow P = \$100 \underbrace{\left\{\frac{1}{.1}\left[1 - \left(\frac{1}{1.1}\right)^3\right]\right\}}_{2.487} = \$248.70$$

$$r = .09 \Rightarrow P = \$100 \underbrace{\left\{\frac{1}{.09}\left[1 - \left(\frac{1}{1.09}\right)^3\right]\right\}}_{2.531} = \$253.10$$

## PENSION FUND CONTRIBUTIONS – AN EXAMPLE

**Employee age: 40**
**Retirement age: 65**
**Desired annual retirement income: $20,000/year for 15 years**
**$r = 10\%$**

***Question:*** **What amount must the employee contribute annually over the 25 years until retirement to guarantee the $20,000 annual payment in the first 15 years following retirement?**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Amount** | | x | x | x | 20 | 20 | 20 |
| **Time** | 0 | 1 | 2 | 25 | 26 | 27 | 40 |
| **Employee Age** | 40 | 41 | 42 | 65 | 66 | 67 | 80 |

***Solution:***

1. **Calculate value as of beginning of period 26 (end 25) of retirement annuity, Z**

$$Z = 20\,A^{15}_{10} = 20\left\{\underbrace{\frac{1}{.1}\left[1-\left(\frac{1}{1.1}\right)^{15}\right]}_{7.606}\right\} = 152{,}122$$

2. **Calculate value as of beginning of period 1 of retirement annuity, Y**

$$Y = \frac{Z}{(1+r)^{25}} = \frac{152{,}122}{(1.1)^{25}} = \$14{,}040.21$$

3. **Calculate annual payment for 25 year annuity with present value equivalent to Y:**

$$14{,}040.21 = XA^{25}_{10} = X\left\{\underbrace{\frac{1}{.1}\left[1-\left(\frac{1}{1.1}\right)^{25}\right]}_{9.077}\right\}$$

$$X = \$1{,}546.78$$

***Question:*** **Is this prudent pension policy?**

## NOMINAL INTEREST RATES AND INFLATION

$r = 10\%$ includes investors' estimates of future inflation

$r = \mu + \pi$

where $\mu$ = "real" interest rate
$\pi$ = expected inflation rate

e.g., $\mu = .04$ $\pi = .06$

If expectations are correct, real value of \$20,000 in year 26 is:

$$\frac{20}{(1.06)^{26}} = 20\,(.220) = \$4400$$

To ensure real value of \$20,000, need

$$20{,}000\,(1.06)^{26} = \$90{,}988 \quad \text{in year 26}$$
$$20{,}000\,(1.06)^{27} = \$96{,}447 \quad \text{in year 27, etc.}$$

## NOMINAL INTEREST RATES AND INFLATION (cont'd)

**Exact relation between inflation and interest rates.**

**Invest $1000 for one year at 15%:**
**(expected inflation is 12%)**

**Now** — **$1000** ---------------------------> invest at 15% to get future value

**Date 1** — **$1150** (nominal = actual # of dollar bills in acct)

deflate at 12% to get purchasing power in current dollars

$$\frac{1150}{1.12} = \$1027$$

(real value of money in acct)

**Result: As if funds invested at real interest rate of**

$$\frac{1027}{1000} - 1 = 2.7\%$$

**Therefore,**

$$1+\text{real rate} = \frac{1 + \text{nominal rate}}{1 + \text{inflation rate}}$$

**or,**

$$u = r - \pi$$

**Must always discount nominal cash flows at nominal rate, real cash flows at real rate:**

$$PV = \$1000 = \frac{1150}{1.15} = \frac{1027}{1.027}$$

## MORTGAGE PAYMENTS – ANOTHER EXAMPLE

**Home value: $100,000**
**Down payment: 10%**
**APR (compounded monthly): 12%**
**Mortgage term: 20 years**

***Question:*** **What are monthly payments on the mortgage?**
***Solution:***

1) **Mortgage amount:** $100{,}000\,(.9) = \$90{,}000$

2) **Payments (x):** $$90{,}000 = x\left\{\frac{1}{r}\left[1-\left(\frac{1}{1+r}\right)^{Tn}\right]\right\}$$

where $r = \frac{APR}{n}$ = effective monthly interest rate
T = mortgage term in years
n = frequency of compounding per year

$$\Rightarrow \quad r = \frac{.12}{12} = .01, \text{ and } 90{,}000 = x\left\{\frac{1}{.01}\left[1-\left(\frac{1}{1.01}\right)^{240}\right]\right\}$$

$$x = \frac{90{,}000}{90.82} = \$990.97$$

**Mortgage Amortization Schedule:**

| Payment | Interest | Principal | Remaining Balance |
|---|---|---|---|
| 1 | 900.00 | 90.97 | 89,909.03 |
| 2 | 899.09 | 91.88 | 89,817.15 |
| 3 | 898.17 | 92.80 | 89,724.35 |
| • | • | • | • |
| • | • | • | • |
| • | • | • | • |
| 240 | 9.81 | 981.16 | 0 |

WHARTON REPROGRAPHICS

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# THE RULES OF CAPITAL BUDGETING

## CAPITAL BUDGETING CRITERION

**Purchase assets with value exceeding asset cost.**

**Formalize as net present value (NPV) using discounting techniques:**

$$NPV = C_0 + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \cdots + \frac{C_T}{(1+r)^T}$$

**PV (future cash flows)**

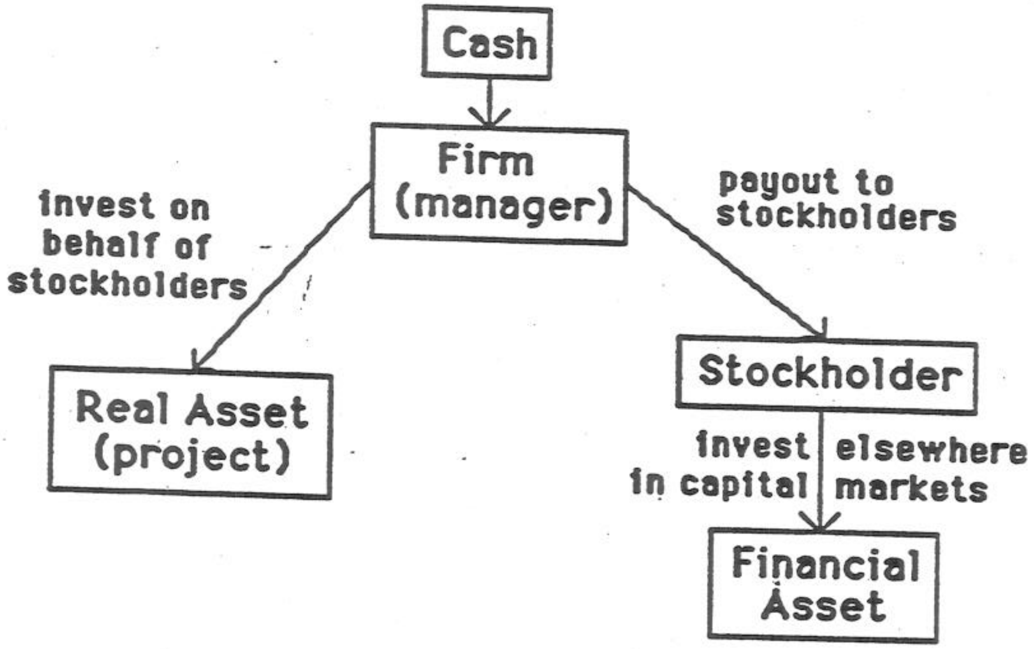
***Rule:*** **Accept project if NPV > 0**
**Reject if NPV < 0**

***Perspective:*** **Converting shareholder contributions into assets of greater value and thereby increasing shareholder wealth.**

**What determines the discount rate to be used on the cash flows from a risky project?**

## CAPITAL BUDGETING CRITERION (cont'd)

For *any* asset, $$PV = \sum_t \frac{\text{expected cash flow at t}}{(1+\text{required return})^t}$$



From the perspective of firm's stockholders, projects the firm invests in must offer at least as high a return as competitive assets of the "same risk" available in capital markets.

## TWO TYPES OF DECISIONS:

1. Accept/Reject
2. Ranking Mutually Exclusive Projects

**1. Example: Machine purchase.**

| $C_0$ | $C_1$ |
|---|---|
| -1750 | 2000 |

***Question:*** Should firm buy machine?

***Solution:*** Buy if $NPV = -1750 + \frac{2000}{1 + r} > 0$

$r = 10\% \Rightarrow NPV = -1750 + 1818 = 68$ Accept.
$r = 15\% \Rightarrow NPV = -1750 + 1739 = -11$ Reject.

**2. Example: Two machines to perform the same task.**

| | $C_0$ | $C_1$ |
|---|---|---|
| A | -1000 | 2000 |
| B | -10,000 | 15,000 |

***Question:*** Which machine should firm buy?

***Solution:*** $r = 10\% \Rightarrow NPV_A = -1000 + \frac{2000}{1.1} = 818$

$$NPV_B = -10{,}000 + \frac{15{,}000}{1.1} = 3636$$

$\Rightarrow$ Choose machine B -- adds most to shareholder wealth

# ALTERNATIVE PROJECT SELECTION CRITERIA

1. Payback
2. Internal Rate of Return (IRR)
3. Average Return on Book Value
4. Profitability Index

Compare criteria to NPV rule with respect to:

1. Accept/reject decisions
2. Ranking mutually exclusive projects

## PAYBACK

| Project | $C_0$ | $C_1$ | $C_2$ | $C_3$ | NPV (r = .12) |
|---|---|---|---|---|---|
| A | -5 | 5 | 0 | 0 | -0.5 |
| B | -5 | 3 | 2 | 4 | 2.1 |
| C | -5 | 1 | 4 | 4 | 1.9 |
| D | -5 | 3 | 2 | 20 | 13.5 |

Payback period (p) = number of years before sum of cash flows exceeds initial outlay.

eg., $p_A = 1$; $p_B = 2$; $p_C = 2$; $p_D = 2$

### ACCEPT/REJECT RULE:

1. Choose $p^*$
2. Accept if $p \leq p^*$
   Reject if $p > p^*$

$p^* = 1$ => accept A and reject B, C, D (versus NPV)
$p^* = 2$ => accept A, B, C, D

### FAILURES OF PAYBACK:

1. Ignores time value of money.
2. Ignores cash flows for $t > p^*$.
3. Arbitrary choice of $p^*$.

### RANKING MUTUALLY EXCLUSIVE PROJECTS:

$A > B = C = D$ since $p_A < p_B = p_C = p_D$
But NPV => $D > B > C$, and never accept A

## INTERNAL RATE OF RETURN (i)

Given cash flows $C_0, C_1, C_2, \ldots, C_T$ the IRR, i, is defined as the discount rate which makes the discounted cash flows equal to 0:

$$0 = C_0 + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \ldots + \frac{C_T}{(1+r)^T}$$

### ACCEPT/REJECT CRITERION:

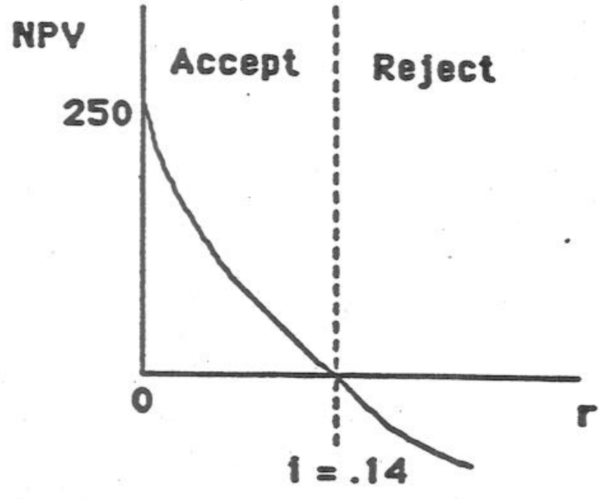
Example: Machine purchase

| $C_0$ | $C_1$ |
|---|---|
| -1750 | 2000 |

$$\Rightarrow \quad 0 = -1750 + \frac{2000}{1+i} \qquad 1750 = \frac{2000}{1+i}$$

$$1+i = \frac{2000}{1750} = 1.14 \qquad \Rightarrow \quad i = 14\%$$

Accept if $i > r$; reject if $i < r$.



r = 10% => accept
r = 15% => reject

equivalent to NPV choice

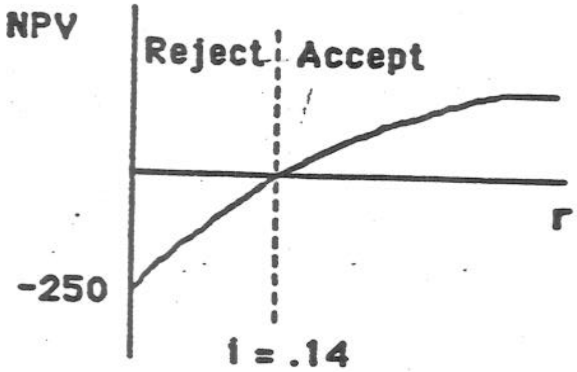
## POTENTIAL PROBLEMS WITH IRR

### 1. Borrowing/Lending

| $C_0$ | $C_1$ |
|---|---|
| 1750 | -2000 |

$$\Rightarrow \quad 0 = 1750 - \frac{2000}{1+i} \qquad 1750 = \frac{2000}{1+i}$$

$$1+i = \frac{2000}{1750} = 1.14 \qquad \Rightarrow \quad i = 14\%$$



Reverse accept/reject decision rule, i.e.,

Accept if $i < r$;
Reject if $i > r$.

Intuition: i is cost of funds internal to project so reject if $i > r$, the cost of alternative financing.

## POTENTIAL PROBLEMS WITH IRR (cont'd)

### 2. Multiple Rates of Return (Project Lasting > 2 Periods)

| Project | $C_0$ | $C_1$ | $C_2$ | NPV (r = .10) |
|---|---|---|---|---|
| A | -4 | 25 | -25 | -1.9 |
| B | -4 | 2 | 4 | 1.1 |
| C | 1 | -3 | 2.5 | 0.3 |

**Using IRR to accept/reject:**

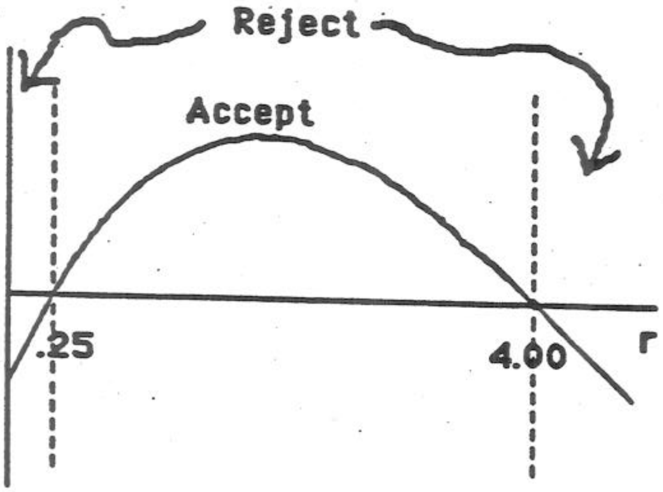
A: $$0 = -4 + \frac{25}{1+i} - \frac{25}{(1+i)^2}$$

$i_1 = 25\%$ (answer from calculator)

$i_2 = 400\%$

***Question:*** Suppose r = 10%. Accept or reject project A?

***Solution:***



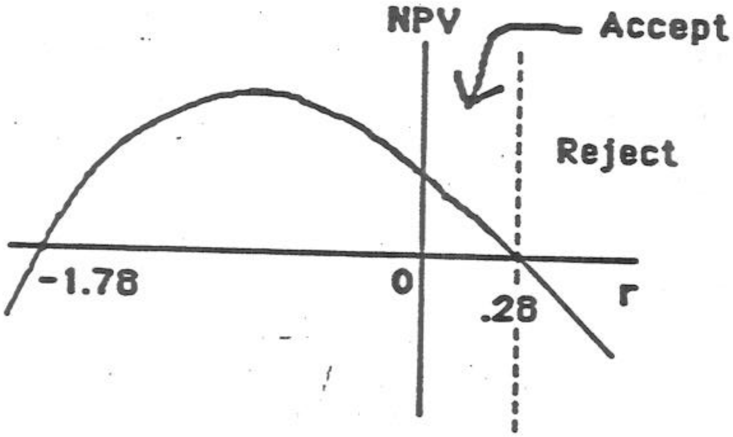
Reject project A.

Using IRR to accept/reject:

B: $0 = -4 + \frac{2}{1+i} + \frac{4}{(1+i)^2}$

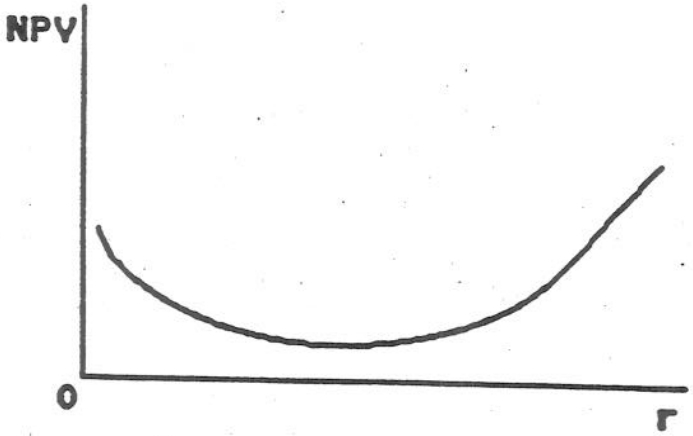
$i_1 = -178\%$

$i_2 = 28\%$
(answer from calculator)



C: $0 = 1 - \frac{3}{1+i} + \frac{2.5}{(1+i)^2}$

No "real-valued" solutions



Accept independent of the discount rate.

## A HELPFUL RESULT

The number of positive IRR's can never exceed the number of changes in the signs of the cash flows.

| Project | Maximum Positive IRR's | Actual IRR's |
|---|---|---|
| A | 2 | 2 |
| B | 1 | 1 |
| C | 2 | 0 |

Vast majority of projects have $C_0 < 0$, $C_1, C_2, \ldots, C_T > 0$ i.e., one change in sign.

Then check for borrowing/lending and apply appropriate rule.

Example:

|  | $C_0$ | $C_1$ | $C_2$ |
|---|---|---|---|
| B | -4 | 2 | 4 |

a) 1 change in sign => 1 IRR (I = 28%)
b) "lending" project

therefore, accept if $r < 28\%$
reject if $r > 28\%$

## USING IRR TO RANK MUTUALLY EXCLUSIVE PROJECTS

Example: Which machine should the firm buy?

| | $C_0$ | $C_1$ | NPV (r = 10%) | IRR |
|---|---|---|---|---|
| A | -1000 | 2000 | 818 | 100% |
| B | -10,000 | 15,000 | 3636 | 50% |

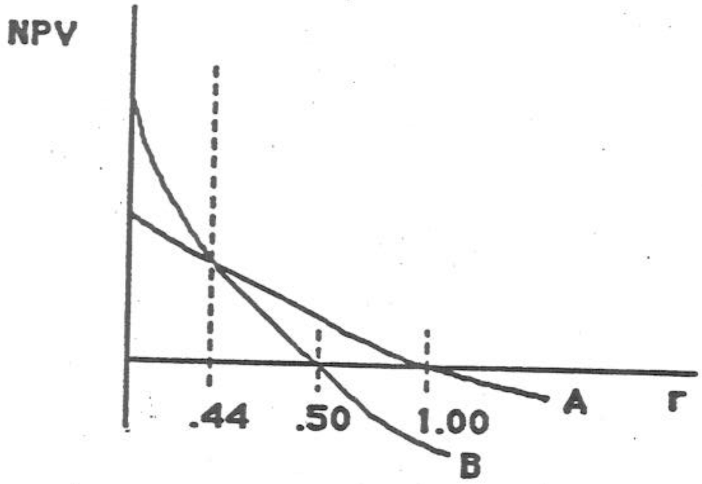
Scale complication if $i_A > i_B$ but $-C_0^A < -C_0^B$,
i.e., if lower return project is larger.

Incremental cash flow approach to reconcile IRR ranking with that of NPV:

| | $C_0$ | $C_1$ | NPV(B-A) (r = 10%) | $IRR_{B-A}$ |
|---|---|---|---|---|
| B - A | -9000 | 13,000 | 2818 | 44% |

Accept B over A if $i_{B-A} > r$ (since lending project),
e.g., choose B instead of A if r = 10%.

## CAN'T RANK PROJECTS USING IRR



Prefer A to B if NPV(A) > NPV(B).

$$NPV(A) - NPV(B) = \sum \frac{CF_t(A)}{(1+r)^t} - \sum \frac{CF_t(B)}{(1+r)^t}$$

$$= \sum \frac{CF_t(A) - CF_t(B)}{(1+r)^t}$$

= NPV (incremental cash flows of A over B)

=> Prefer A to B if NPV(incremental cash flows) > 0.

What is IRR of these incremental cash flows?

## PROJECT INTERACTIONS

**Comparing mutually exclusive projects with different lives.**

**Example: Choosing between two machines which perform same task equally efficiently**

| Machine | $C_0$ | $C_1$ | $C_2$ | $C_3$ | $C_4$ |
|---|---|---|---|---|---|
| A | 40 | 10 | 10 | 10 + replace | |
| B | 50 | 8 | 8 | 8 | 8 + replace |

**Approaches:**

1. **Salvage value:**

**Estimate salvage value of machine B and compare assets over same (3-year) life.**

**Suppose machine B's market value at end year 3 is 12.5. Then (if no tax implications of sale of B),**

$$PV(\text{Costs of A}) = 40 + 10A^3_r$$

$$PV(\text{Costs of B}) = 50 + 8A^3_r - \frac{12.5}{(1+r)^3}$$

$r = 10\% \Rightarrow$ NPV(Costs of A)= 64.9
NPV(Costs of B) = 60.5

**B is lower cost machine**

## Approaches (continued):

### 2. Matching cycles:

If repeat A for 4 cycles, and B for 3, projects can be compared over same 12-year life.

| | $C_0$ | $C_1$ | $C_2$ | $C_3$ | $C_4$ | ... | $C_{12}$ | |
|---|---|---|---|---|---|---|---|---|
| A | 40 | 10 | 10 | 10 + 40 | 10 | | 10 | don't |
| B | 50 | 8 | 8 | 8 | 8 + 50 | | 8 | replace |

Can ease calculation:

$$PV_A \text{ (one cycle)} = 40 + 10A^3_{.1} = 64.9$$
$$PV_B \text{ (one cycle)} = 50 + 8A^4_{.1} = 75.4$$

$$\Rightarrow PV(\text{Costs of A,12-yr}) = 64.9 + \frac{64.9}{(1.1)^3} + \frac{64.9}{(1.1)^6} + \frac{64.9}{(1.1)^9} = 177.8$$

$$PV(\text{Costs of B,12-yr}) = 75.4 + \frac{75.4}{(1.1)^4} + \frac{75.4}{(1.1)^8} = 162.1$$

B is the lower cost machine.

Approaches (continued):

3. Perpetual replacement:

```
PVA = 64.9          64.9                 64.9
--|------|------|------|------|------|------|---> . . .
PVB = 75.4                 75.4
```

If we convert each "lumpy" stream into a "smooth" one, we can compare them directly.

What is the 3-year *annuity* with the same PV as A?

$$PV_A = 64.9 = x\,A^{3}_{10} \quad \Rightarrow \quad x = 26.1$$

What is the 4-year *annuity* with the same PV as B?

$$PV_B = 75.4 = y\,A^{4}_{10} \quad \Rightarrow \quad y = 23.8$$

Do this for *each* cycle, and stack them up:

```
A  26.1  26.1  26.1  26.1  26.1  26.1  26.1  26.1
------|-----|-----|-----|-----|-----|-----|-----|---> . . .
B  23.8  23.8  23.8  23.8  23.8  23.8  23.8  23.8
```

=> The "equivalent annual cost" of B is lower.

*Question:* What are the advantages of the salvage value method?

4

WHARTON REPROGRAPHICS

# THE PRACTICE OF CAPITAL BUDGETING

## RULES FOR PROJECT SELECTION

1. $$\text{NPV} = \sum_{t=0}^{T} \frac{C_t}{(1+r)^t}$$

   Accept if NPV > 0; reject if NPV < 0

2. $$\text{IRR} = \sum_{t=0}^{T} \frac{C_t}{(1+i)^t}$$

   Accept if i > r; reject if i < r ("lending" project)

Given r, must forecast expected cash flows $C_t$.

*Distinction:* Accounting data vs. $C_t$; need actual cash flows -- NOT accounting income.

## UNLEVERED VALUATION (cont'd)

### DERIVING CASH FLOW FROM THE INCOME STATEMENT

Begin with cash-based income statement:

Example: Rhem, Inc.

Rhem is about to purchase $30M of machinery, which would be depreciated straight line over its two year life. It has made the following income projections:

Cost of good sold: 40% of sales
SG&A: 10% of sales Tax rate: 40%

| Projected Income Statement—1995 ($M) | | Projected Cash Flow—1995 ($M) |
|---|---|---|
| Sales | 50 | |
| Cost of Goods Sold | 20 | |
| Depreciation | 15 | |
| SG&A | 5 | |
| Operating Income | 10 | |
| Corporate Tax | 4 | |
| AT Operating Income | 6 | |

## CASH FLOW DETERMINATION

### METHOD 1: A quick and dirty 'FFO'

$$C_t = EAT_t + Dep_t$$

where: $EAT_t$ = income after tax
$Dep_t$ = depreciation (non-cash expenses)

Simply add non-cash expenses back to after tax income.

## CASH FLOW DETERMINATION (cont'd)

METHOD 2:

$$C_t = (R_t - CC_t - \text{taxes}_t)$$

where: R = revenue
CC = cash costs

But $\text{taxes}_t = T_C\ (R_t - CC_t - \text{Dep}_t)$

where $T_C$ = the corporate tax rate

Therefore, $C_t = R_t - CC_t - T_C\ (R_t - CC_t - \text{Dep}_t)$

$$C_t = \underbrace{(R_t - CC_t)(1 - T_C)}_{\text{net after-tax cash}} + \underbrace{T_C\text{Dep}_t}_{\text{depreciation tax shield}}$$

What is impact on cash flow if . . .

Sales rise by $1?
Materials costs rise by $1?
Depreciation expense rises by $1?
(accelerated depreciation)

# RHEM INC'S CAPITAL BUDGETING DECISION

Suppose

- Rhem projects stable cash flows over two-year life
- appropriate discount rate: 12%

Should it go ahead with the investment?

Calculate NPV of project:

Calculate IRR of project:

## ADDING REALISM TO RHEM CASH FLOW CALCULATIONS

Suppose firm needs $2M cash and $3M inventory to begin operation.

Initial balance sheet:

Balance Sheet—1/1/95
($M)

| | | | |
|---|---|---|---|
| Cash | 2 | Equity | 35 |
| Inventory | 3 | | |
| Plt. & Equip. | 30 | | |

If all sales and purchases are for cash, end-of-year balance sheets might look like:

(Assume ending inventory remains constant)

Balance Sheet —12/31/95
($M)

| | | | |
|---|---|---|---|
| Cash | 23 | Equity | 35 |
| Inventory | 3 | Ret. Earnings | 6 |
| Plt. & Equip. | 15 | | |

Balance Sheet—12/31/96
($M)

| | | | |
|---|---|---|---|
| Cash | 44 | Equity | 35 |
| Inventory | 3 | Ret. Earnings | 12 |
| Plt. & Equip. | 0 | | |

## CHANGES IN RHEM WORKING CAPITAL

Starting from balance sheets on previous page, suppose now the $10M of '95 sales are credit, payment to be received in'96; and all '95 sales are for cash.

How would end '95 and end '96 balance sheets look?

| Balance Sheet—12/31/95<br>($M) | Balance Sheet—12/31/96<br>($M) |
|---|---|

## RHEM INC (cont'd)

**With the balance sheets as amended on previous page, calculate projected cash flows for '95 and '96.**

| Projected Cash Flow—1995<br>($M) | Projected Cash Flow—1996<br>($M) |
|---|---|

**With these projections, what are the NPV and IRR for this project?**

## IMPORTANT CONSIDERATIONS

1. Analyze cash flows of firm with -- vs. without -- project (incremental cash flows).

e.g.,
- a) Proctor and Gamble: new laundry detergent
- b) TWA: Philadelphia - New York flight

2. Cash flow impact of changes in working capital (accounts receivable, inventory, accounts payable).

e.g., Sales = $50, but $20 of sales on credit terms
=> Cash revenue = 50 - 20 = $30

Therefore, increase in working capital (increase in accounts receivable) means reduction in cash flow.

Increase in inventory means accounting costs understate cash outlays for raw materials, etc.

3. Include all opportunity costs (foregone cash flows of alternative strategies).

Methods:

- A. Opportunity cost in NPV.
- B. Separate calculation of cash flows to alternative strategies.

# DECIDING ON AN MBA – AN EXAMPLE OF OPPORTUNITY COST

| | |
|---|---|
| **Current employment:** | **$30,000/year, grow at 10%/year** |
| **Cost of Wharton education:** | **$15,000/year, grow at 6%/year** |
| **Salary with MBA:** | **Start at $40,000/year, grow at 12%/year** |
| **Remaining working life:** | **40 years** |
| **Discount rate:** | **20%** (Ignore taxes) |

**Method 2: (Cash flows to two strategies)**

**a) Retain current position**

| $C_1$ | $C_2$ | $C_3$ | ... |
|---|---|---|---|
| 30 | 30 (1.1) | $30\ (1.1)^2$ | |

$$PV = \frac{30}{(.2-.1)}\left[1-\left(\frac{1.1}{1.2}\right)^{40}\right] = 290.76$$

**b) Go to Wharton**

| $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | ... |
|---|---|---|---|---|---|
| -15 | -15 (1.06) | 40 | 40 (1.12) | $40\ (1.12)^2$ | |

$$PV = -15\left\{\frac{1}{(.2-.06)}\left[1-\left(\frac{1.06}{1.2}\right)^{2}\right]\right\} + \frac{40}{(1.2)^2}\left\{\frac{1}{(.2-.12)}\left[1-\left(\frac{1.12}{1.2}\right)^{38}\right]\right\}$$

$= -23.54 + 321.99 = 298.45 \Rightarrow$ **(Surprise !) Go to Wharton.**

**Method 1: (NPV including cash flows foregone by deciding on business school)**

| $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | ... |
|---|---|---|---|---|---|
| -15<br>-30 | -15 (1.06)<br>-30 (1.1) | 40<br>$-30\ (1.1)^2$ | 40 (1.12)<br>$-30\ (1.1)^3$ | $40\ (1.12)^2$<br>$-30\ (1.1)^4$ | |

$NPV_{B\ School} = 298.45 - 290.76 = 7.69 \quad \Rightarrow$ **Go to Wharton**

## DIRECT CASH FLOW EFFECTS OF PURCHASE AND SALE OF CAPITAL ASSETS

A. Initial Cash Outlay
B. Depreciation
C. Resale of Used Asset

**Example: Purchase of $1 million asset in 5-year class.**

A. Initial cash outlay: $\frac{C_0}{-1000}$ (cannot be expensed)

## B. Depreciation

### Schedule of Depreciation Expense Proportions Under 1986 Tax Code

Schedule of Depreciation Expense Proportions
Under 1986 Tax Code

| Year | 3 Year | 5 Year | 7 Year | 10 Year | 15 Year | 20 Year |
|---|---|---|---|---|---|---|
| 1 | 0.333 | 0.200 | 0.143 | 0.100 | 0.050 | 0.038 |
| 2 | 0.444 | 0.320 | 0.245 | 0.180 | 0.095 | 0.072 |
| 3 | 0.148 | 0.192 | 0.175 | 0.144 | 0.086 | 0.067 |
| 4 | 0.074 | 0.115 | 0.125 | 0.115 | 0.077 | 0.062 |
| 5 |  | 0.115 | 0.089 | 0.092 | 0.069 | 0.057 |
| 6 |  | 0.058 | 0.089 | 0.074 | 0.062 | 0.053 |
| 7 |  |  | 0.089 | 0.066 | 0.059 | 0.049 |
| 8 |  |  | 0.045 | 0.066 | 0.059 | 0.045 |
| 9 |  |  |  | 0.066 | 0.059 | 0.045 |
| 10 |  |  |  | 0.066 | 0.059 | 0.045 |
| 11 |  |  |  | 0.033 | 0.059 | 0.045 |
| 12 |  |  |  |  | 0.059 | 0.045 |
| 13 |  |  |  |  | 0.059 | 0.0[illegible] |
| 14 |  |  |  |  | 0.059 | 0.0[illegible] |
| 15 |  |  |  |  | 0.059 | 0.045 |
| 16 |  |  |  |  | 0.030 | 0.045 |
| 17 |  |  |  |  |  | 0.045 |
| 18 |  |  |  |  |  | 0.045 |
| 19 |  |  |  |  |  | 0.045 |
| 20 |  |  |  |  |  | 0.045 |
| 21 |  |  |  |  |  | 0.022 |

Depreciation expense on $1 million purchase in each year is:

$D_1 = .200\ (1000) = 200$
$D_2 = .320\ (1000) = 320$
$D_3 = .192\ (1000) = 192$
$D_4 = .115\ (1000) = 115$
$D_5 = .115\ (1000) = 115$
$D_6 = .058\ (1000) = 58$

Cash flows from depreciation tax shield (assuming firm is in 34% tax bracket in each year) = $T_cD_t$:

| $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ |
|---|---|---|---|---|---|
| 68.00 | 108.80 | 65.28 | 39.10 | 39.10 | 19.72 |

$$PV = \frac{68.00}{1+r} + \frac{108.80}{(1+r)^2} + \frac{65.28}{(1+r)^3} + \frac{39.10}{(1+r)^4} + \frac{39.10}{(1+r)^5} + \frac{19.72}{(1+r)^6}$$

$r = 10\%$ => $PV = 262.90$

**Example: (continued)**

**Present value of depreciation tax shields:**

$$PV = \text{Base} \times T_c \times \underbrace{\left\{ \frac{.200}{1+r} + \frac{.320}{(1+r)^2} + \frac{.192}{(1+r)^3} + \frac{.115}{(1+r)^4} + \frac{.115}{(1+r)^5} + \frac{.058}{(1+r)^6} \right\}}_{Z}$$

**Present Value of Depreciation Charges Per Dollar of Depreciable Basis under 1986 Tax Code**

| Interest Rate | 3 Year | 5 Year | 7 Year | 10 Year | 15 Year | 20 Year |
|---|---|---|---|---|---|---|
| 1% | 0.9807 | 0.9726 | 0.9648 | 0.9533 | 0.9259 | 0.9054 |
| 2% | 0.9620 | 0.9465 | 0.9316 | 0.9101 | 0.8595 | 0.8234 |
| 3% | 0.9439 | 0.9215 | 0.9002 | 0.8698 | 0.8001 | 0.7520 |
| 4% | 0.9264 | 0.8975 | 0.8704 | 0.8324 | 0.7466 | 0.6896 |
| 5% | 0.9095 | 0.8746 | 0.8422 | 0.7975 | 0.6984 | 0.6349 |
| 6% | 0.8931 | 0.8526 | 0.8155 | 0.7649 | 0.6549 | 0.58 |
| 7% | 0.8772 | 0.8315 | 0.7902 | 0.7344 | 0.6155 | 0.54 |
| 8% | 0.8617 | 0.8113 | 0.7661 | 0.7059 | 0.5797 | 0.50 |
| 9% | 0.8468 | 0.7919 | 0.7432 | 0.6792 | 0.5471 | 0.4725 |
| 10% | 0.8322 | 0.7733 | 0.7214 | 0.6541 | 0.5173 | 0.4424 |
| 11% | 0.8181 | 0.7553 | 0.7007 | 0.6306 | 0.4901 | 0.4154 |
| 12% | 0.8045 | 0.7381 | 0.6810 | 0.6084 | 0.4652 | 0.3911 |
| 13% | 0.7912 | 0.7215 | 0.6621 | 0.5875 | 0.4423 | 0.3691 |
| 14% | 0.7782 | 0.7055 | 0.6441 | 0.5678 | 0.4213 | 0.3492 |
| 15% | 0.7657 | 0.6902 | 0.6270 | 0.5492 | 0.4019 | 0.3311 |
| 16% | 0.7535 | 0.6753 | 0.6105 | 0.5317 | 0.3839 | 0.3146 |
| 17% | 0.7416 | 0.6611 | 0.5948 | 0.5150 | 0.3673 | 0.2995 |
| 18% | 0.7301 | 0.6473 | 0.5798 | 0.4993 | 0.3519 | 0.2856 |
| 19% | 0.7188 | 0.6340 | 0.5654 | 0.4844 | 0.3376 | 0.2729 |
| 20% | 0.7079 | 0.6211 | 0.5516 | 0.4702 | 0.3242 | 0.2612 |
| 21% | 0.6972 | 0.6087 | 0.5384 | 0.4567 | 0.3118 | 0.2503 |
| 22% | 0.6869 | 0.5968 | 0.5257 | 0.4439 | 0.3002 | 0.2403 |
| 23% | 0.6767 | 0.5852 | 0.5136 | 0.4317 | 0.2893 | 0.2310 |
| 24% | 0.6669 | 0.5740 | 0.5019 | 0.4201 | 0.2791 | 0.2223 |
| 25% | 0.6573 | 0.5631 | 0.4906 | 0.4090 | 0.2696 | 0.2142 |

**Z (5-year; r = 10%) = .7733**

**=> PV = 1,000(.34).7733 = 262.92**

Example: (continued)

## C. Resale of Used Asset:

Sell asset for $500,000.

Calculation of resulting cash flow:

| | |
|---|---|
| Resale price | 500 |
| Book value | -0- |
| Taxable gain | 500 |

=> $C_5 = 500\,(1-T_c) = 500\,(.66) = 330$

# VALUING STOCKS AND BONDS

# VALUATION OF STOCKS AND BONDS

Corporations (and governments) issue financial assets – claims on future cash flows generated by real assets.

Evaluate using expected cash flows and appropriate discount rates.

Real assets of corporation determine overall cash flows.

Debt/equity financing decisions affect distribution to holders of different claims on firm.

Valuation of stocks and bonds => ability to determine impact on value of corporation of altering capital structure.

## A. EQUITY

Cash flows -- dividends and/or capital gains.

Appropriate discount rate -- return expected on investment of "comparable risk."

Capital Asset Pricing Model (CAPM) -- quantifying the risk.

**CAPM Concepts:**

1. Investors prefer higher expected return, lower variability of return.
2. Returns are less volatile for given expected return as number of assets held increases.
3. Prescription from #2: diversify.
4. For diversified investor, risk of particular asset is not volatility of own return, but contribution to variability of return on remainder of portfolio. This depends on covariability of asset's return with that on diversified portfolio, e.g., the market. Standardized measure of this covariability: ß.
5. $r_j = r_F$ + risk premium
   & risk premium therefore depends on asset ß.

## STOCK VALUATION

Investor with 1-year holding period willing to pay:

$P_0 = \frac{DIV_1 + P_1}{1+r}$ for stock with single, end-of-year dividend $DIV_1$, and price at year-end $P_1$.

But buyer of share at year-end willing to pay: $P_1 = \frac{DIV_2 + P_2}{1+r}$.

Therefore, $$P_0 = \frac{1}{1+r}\left\{ DIV_1 + \frac{DIV_2 + P_2}{1+r} \right\}$$

Or, $$P_0 = \frac{DIV_1}{1+r} + \frac{DIV_2}{(1+r)^2} + \frac{P_2}{(1+r)^2}$$

Continuing this logic,

$$P_0 = \frac{DIV_1}{1+r} + \frac{DIV_2}{(1+r)^2} + \frac{DIV_3}{(1+r)^3} + \ldots = \sum_{t=1}^{\infty} \frac{DIV_t}{(1+r)^t}$$

Special cases:

1. Constant dividends: $DIV_1 = DIV_2 = \ldots$

$$P_0 = \frac{DIV_1}{1+r} + \frac{DIV_1}{(1+r)^2} + \frac{DIV_1}{(1+r)^3} + \ldots = \frac{DIV_1}{r}$$

2. Dividends growing at constant rate:

$DIV_2 = (1+g)DIV_1$; $DIV_3 = (1+g)DIV_2$, etc.

$$P_0 = \frac{DIV_1}{1+r} + \frac{(1+g)DIV_1}{(1+r)^2} + \frac{(1+g)^2 DIV_1}{(1+r)^3} + \ldots = \frac{DIV_1}{r-g} \qquad (g<r)$$

*Caveats:* growth rarely constant;
r difficult to estimate for particular firm.

## DETERMINANTS OF GROWTH

$$g = \underbrace{ROE}_{\text{return on equity}} \times \underbrace{PB}_{\text{plowback} = \frac{R.E.PS}{EPS}}$$

**Example:**

Earnings = \$4 million
ROE = .2
PB = .6

R.E. = (.6)(4) = 2.4 => invested at ROE of .2

=> Increase in earnings = (.6)(.2)(4) = .48

Therefore, growth in earnings is:

$$= \frac{\text{increase in earnings}}{\text{earnings}} = \frac{(.6)(.2)(4)}{4} = \frac{.48}{4} = .12$$

## "INCOME" VERSUS "GROWTH" STOCKS

Prototypical "income" stock:

$$\begin{tikzcd}
PB = 0 \arrow[r, Rightarrow] \arrow[dr] & g = 0 \\
& DIV = EPS
\end{tikzcd}$$

Therefore, $P_0 = \frac{DIV_1}{r-g} = \frac{EPS_1}{r}$

"Growth" stock:

$$P_0 = \underbrace{\frac{EPS_1}{r}}_{\text{value if full payout}} + \underbrace{PVGO}_{\text{value of reinvesting part of earnings}}$$

Growth occurs as long as some earnings are retained.

But growth, *per se*, does not raise share value.

Only growth generated by earnings retained and invested in positive NPV opportunities creates PVGO and $P_0 > \frac{EPS_1}{r}$.

If R.E. invested in projects with ROE < r, the corporation grows, but investor would have earned higher return if earnings paid out instead of retained, i.e., PVGO < 0.

## PRICE - EARNINGS RATIO

$$P_0 = \frac{EPS_1}{r} + PVGO \quad \Rightarrow$$

$$\frac{P_0}{EPS_1} = \frac{1}{r} + \frac{PVGO}{EPS_1}$$

Traditional view: $r$, $EPS_1$ held constant.

$\frac{P_0}{EPS_1}$ higher for firms with growth opportunities (PVGO)

*Caveats* : Assumes risk (r) and $EPS_1$ are same across firms being compared.

When measuring EPS,

Want prospective, not historical EPS.

Accounting variations bias reported earnings.

## B. BONDS

More predictable cash flow pattern -- coupon and principal schedule.

Discount Bonds (e.g., Treasury bills):

1. Single promised payment -- face value.
2. Difference between face value and purchase price treated as interest for personal tax purposes.

Coupon Bonds (e.g., Treasury notes or bonds):

1. Pay regular coupon payments (at 6 month intervals) in addition to face value.
2. Coupons treated as interest for tax purposes; difference between face value and purchase price treated as capital gain.

## GOVERNMENT FIXED INCOME SECURITIES

Maturity at issue:

| | |
|---|---|
| Bills | up to 12 months |
| Notes | 1–7 years |
| Bonds | 7 or more years |

Example: 7s of April 1999 (data from June 9, 1995 WSJ)

| Bid | Asked | Yield |
|---|---|---|
| 103:13 | 103:15 | 5.98 |

Pay $103\frac{15}{32} \times 10 = \$1034.69$ to purchase bond.

Purchase gave investor claim to these cash flows:

| 10/95 | 4/96 | 10/96 | 4/97 | … | 4/99 |
|---|---|---|---|---|---|
| $35 | $35 | $35 | $35 | | $1035 |

$$P = \$1034.69 = \frac{\$35}{1+r_s} + \frac{\$35}{(1+r_s)^2} + \ldots + \frac{\$1035}{(1+r_s)^8}$$

## GOVERNMENT FIXED INCOME SECURITIES (cont'd)

Gov't tables give 'yield.' In this case yield was 5.98%.

$$\mathrm{r_s} \text{ above is equal to } \quad \frac{\text{yield}}{2} = \frac{.0598}{2} = 2.99\% \,.$$

This value of $\mathrm{r_s}$ implies value for bond above of:

$$\mathrm{P_0} = \$1034.69$$

which is very close to market price.

## CORPORATE BOND EXAMPLE

Chrysler 13s of 1997

105 5/8 => $P_o = 1056.25$

Schedule of promised payments:

| 94.2 | 95.1 | 95.2 | 96.1 | 96.2 | 97.1 |
|---|---|---|---|---|---|
| \$65 | \$65 | \$65 | \$65 | \$65 | \$1065 |

Solve for $r_s$ satisfying

$$\$1056.25 = \frac{\$65}{(1 + r_s)} + \frac{\$65}{(1 + r_s)^2} + \dots + \frac{\$1065}{(1 + r_s)^6}$$

$r_s = .054$ => yield of $2 \times .054 = 10.8\%$.

$$\text{Current Yield} = \frac{13}{105\ 5/8} = .123$$

## COUPON (c) VERSUS YIELD TO MATURITY (r)

**At issue, coupon set approximately equal to current risk-adjusted market rate.**

**Bond sells near face value.**

**Example: One Year Note**

$$C_1 = c1000 + 1000$$

$$P = \frac{c1000 + 1000}{(1+r)} = \frac{1000(1+c)}{(1+r)} = 1000 \text{ if } c=r$$

If rates fall, $r < c$ and $P > 1000$ (premium)

If rates rise, $r > c$ and $P < 1000$ (discount)

$$1 + r = \frac{c \cdot 1000}{P} + \frac{1000}{P}$$

$$r = \frac{c \cdot 1000}{P} + \frac{1000 - P}{P}$$

$$\text{Yield to maturity} = \underset{\text{yield}}{\text{current}} + \underset{\text{to maturity}}{\text{appreciation}}$$

## COUPON (c) VERSUS YIELD TO MATURITY (r) (continued)

Example: Bond with 1 year remaining
(annual coupon payment)

$c = 8\%$ $\quad r = 10\%$

$$P = \frac{1080}{1.1} = 981.82$$

$$\text{Current yield} = \frac{80}{981.82} = .082$$

$$\text{Appreciation} = \frac{1000 - 981.82}{981.82} = .018$$

Yield to maturity = .10

$$\text{Yield to maturity} = \underset{\text{yield}}{\text{current}} + \underset{\text{to maturity}}{\text{amortized appreciation}}$$

$$r = \frac{c \cdot 1000}{P} + \frac{(1000-P)/P}{T}$$

(T=years remaining until maturity)

## ZERO COUPON BONDS

Single payment bonds (CATS, TIGRs)

Unbundling coupon payments from government debt – resold as discount debt.

$$P = \frac{cF}{(1+r)}$$

e.g., $c = 13\%$ $r = 11\%$

If semiannual coupon payment, cost of one $65 coupon in one year is:

$$P = \frac{65}{1.11} = \$58.56$$

Original intent: appreciation from 58.56 to 65 taxed as capital gain.

Loophole closed: appreciation in price of original issue discount bond treated as interest.

Remaining benefit: locking in terminal value of investment.

## SHORTCOMINGS OF YIELD TO MATURITY

**Two bonds of same maturity and risk generally have different yields to maturity if coupons differ.**

**Example: Two 2-year government notes (annual coupons)**

$c_A = 5\%$ $\qquad$ $c_B = 12\%$

$P_A = 914.06$ $\qquad$ $P_B = 1036.73$

**Calculate yields to maturity $Y_A$, $Y_B$.**

$$914.06 = \frac{50}{1+Y_A} + \frac{1050}{(1+Y_A)^2} \Rightarrow Y_A = 9.95\%$$

$$1036.73 = \frac{120}{1+Y_B} + \frac{1120}{(1+Y_B)^2} \Rightarrow Y_B = 9.89\%$$

**Does this difference in yields to maturity imply bonds are mispriced?**

# TERM STRUCTURE OF INTEREST RATES

Bond's price is discounted value of coupon and principal payments.

$$P = \frac{cF}{(1+r_1)} + \frac{cF + F}{(1+r_2)^2}$$

Yield to maturity is a geometric weighted average of the spot rates, $r_1$ and $r_2$:

$$P = \frac{cF}{(1+Y)} + \frac{cF + F}{(1+Y)^2}$$

Bonds with different coupons, even with same maturity and risk, will carry different yields to maturity unless:

$r_1 = r_2$ "flat" term structure

General case:

$r_1 \neq r_2$ sloping term structure

## INFERRING THE TERM STRUCTURE

Two zero coupon bonds:

| | $C_1$ | $C_2$ |
|---|---|---|
| A | 1000 | – |
| B | – | 1000 |

$P_A = \$925.93$ $\quad$ $P_B = 826.45$

Can infer the spot rates since

$$P_A = \frac{1000}{1+r_A} \Rightarrow 925.93 = \frac{1000}{1+r_A} \Rightarrow r_A = 8\%$$

$$P_B = \frac{1000}{(1+r_B)^2} \Rightarrow 826.45 = \frac{1000}{(1+r_B)^2} \Rightarrow r_B = 10\%$$

The spot rate, $r_t$, is the yield to maturity of a zero coupon bond maturing t periods from now.

## INFERRING THE TERM STRUCTURE (continued)

Given these spot rates, what should this 5%, two-year bond cost?

| | | |
|---|---|---|
| | $C_1$ | $C_2$ |
| C | 50 | 1050 |

View as portfolio of zero coupon bonds with one- and two-year maturities.

Zero coupon bonds A and B imply:

$r_1 = 8\%$ $\qquad$ $r_2 = 10\%$

Therefore,

$$P_C = \frac{50}{(1+r_1)} + \frac{1050}{(1+r_2)^2} = \$914.06$$

What if this bond actually trades at $914.00?

## INFERRING THE TERM STRUCTURE (continued)

At $914.00, Bond C underpriced *relative* to A and B.

Leads to arbitrage opportunity:

- purchase 20 bonds of type C
  (cost = 914 x 20 = $18,280)
- "strip" these bonds and issue:
  - 1 one-year zero coupon bond with face value $1000 (type A)
    (proceeds = $925.93)
  - 21 two-year zero coupon bonds, each with a face value of $1000 (type B)
    (proceeds = 21 x 826.45 = $17,355.45)
- by construction, future cash flows from purchasing 20 type C bonds *exactly* match future obligations from type A and type B bonds
- transaction nets you $1.38 with zero risk and no future liabilities
- Note: If C was overpriced relative to A and B, run arbitrage in reverse (i.e., buy appropriate portfolio of type A and B bonds to create "synthetic" type C bond)

Arbitrage opportunities quickly eliminated. Process of executing necessary trades drives prices of all three bonds to point where no future profits can be made.

## INFERRING THE TERM STRUCTURE (continued)

If term structure is flat, bonds with same risk and maturity have same yield to maturity even if coupons differ.

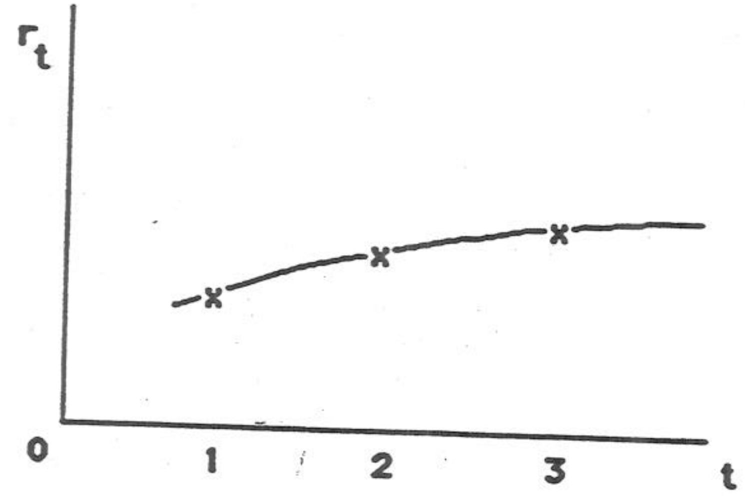
If $r_1 < r_2$, bond with lower coupon offers higher yield to maturity.

Lower coupon => larger share of cash payments on the bond occur later, when spot rates are higher.

Since yield to maturity is weighted average of spot rates, lower coupon bond puts more weight on later dates when spot rates higher.

## INFERRING THE TERM STRUCTURE (continued)

Ideally, graph the term structure – spot rates for different maturities.



Easily done if enough zero coupon government bonds.

Instead, we plot the yield to maturities of many different Treasury securities – the yield curve.

# EXPLANATIONS OF THE TERM STRUCTURE

**What causes the discrepancy among spot rates for different maturities?**

**e.g., $r_1 = 8\%$ $r_2 = 10\%$**

**Suppose two zero coupon bonds are available. Bond I matures in 1 year, bond II in 2 years. Consistent with the above rates, the cash flows associated with each are:**

| | $C_1$ | $C_2$ |
|---|---|---|
| I | 1080 | -- |
| II | -- | 1210 |

**An individual wants to invest $1000 for one year. Two alternatives are available.**

**Strategy 1: Buy bond I and hold to maturity.**

**Earn $\$1000(1+r_1) = 1000(1.08) = 1080$ (certain)**

**Strategy 2: Buy bond II and sell at end of year 1, prior to maturity.**

**Bond II value at end year 1 = $\dfrac{1000(1+r_2)^2}{1+{}_1r_2} = \dfrac{1210}{1+{}_1r_2}$ (uncertain)**

**(${}_1r_2$ = the uncertain spot rate at end year 1 on bond maturing at end year 2.)**

**e.g., If 1 year rate at end of year 1 is 6%, II will then sell for $\dfrac{1210}{1.06} = 1141.51$.**

**Example (continued):**

Investor compares *expected* proceeds from strategies:

| $\underline{1}$ | $\underline{2}$ |
|---|---|
| $1000(1+r_1)$ | $\dfrac{1000(1+r_2)^2}{1+E({}_1r_2)}$ |

Rewrite: $(1+r_2)^2 = (1+r_1)(1+f_2) \Rightarrow f_2 = \dfrac{(1+r_2)^2}{1+r_1} - 1$

($f_2$ = the 1-year rate 1 year from now implicit in the 2-year spot rate (the forward rate).).

e.g., $f_2 = \dfrac{(1.1)^2}{1.08} = .1204$

So comparison of expected returns viewed as:

| $\underline{1}$ | vs. | $\underline{2}$ |
|---|---|---|
| $1000(1+r_1)$ | | $\dfrac{1000(1+r_1)(1+f_2)}{1+E({}_1r_2)}$ |

## A. EXPECTATIONS HYPOTHESIS

The forward rate implicit in the 2-year spot rate is equal to $E({}_1r_2)$, the spot rate investors expect to be able to earn at the end of year 1 on bond maturing at end of year 2.

*Logic:* Investors choose strategy which offers higher expected return.

If $f_2 > E({}_1r_2)$, strategy 2 offers higher expected return and all investors buy the 2-year bond (sell 1-year bond) to achieve investment goal.

=> price of bond II ↑, $r_2$ and, therefore, $f_2$ ↓ until $f_2 = E({}_1r_2)$.

If $f_2 < E({}_1r_2)$, all buy 1-year bond (sell 2-year bond).

=> price of bond II ↓, $r_2$ and $f_2$ ↑ until $f_2 = E({}_1r_2)$.

$$f_2 = E({}_1r_2)$$

*Caution:* Assumes investors only care about expected return -- independent of risk.

## B. LIQUIDITY PREFERENCE

Investors require higher expected return as compensation for risk.

Strategy 1 above is risk free -- strategy 2 offers uncertain return.

=> 2 must offer higher expected return than 1.

$$f_2 > E({}_1r_2)$$

or $(1+r_1)(1+f_2) > (1+r_1)(1+E({}_1r_2))$

=> $(1+r_2)^2 > (1+r_1)(1+E({}_1r_2))$

Spot rate $r_2$ depends on expected future 1-year spot rate but also includes risk premium.

*Note:* Assumes excess demand for short-term bonds.
If not, $f_2 < E({}_1r_2)$.

## SUMMARY

**Evidence:** term structure is, on average, upward sloping.

Reconciling the theories:

Expectations hypothesis correctly indicates that spot rates on long bonds depend on short spot rates expected in the future.

But expectations hypothesis inconsistent with upward sloping term structure over long-run, since this could occur only if investors expect short rates to rise on average.

Liquidity preference explains slope on average if excess demand for short-term bonds, i.e., investors demand short bonds relatively more heavily than these are issued by firms/government.

Note: Downward sloping term structure consistent with liquidity preference hypothesis if future spot rates expected to fall.

Inflation uncertainty also explains upward slope.

*Key:* Slope indicates compensation for risk -- not necessarily opportunity for excess returns.

## CORPORATE DEBT

Debt issued by corporations generally riskier than government debt – higher probability of default.

Example: Firm issues 1-year debt with coupon rate of 10%.
90% chance firm repays full principal and interest.
10% chance firm in bankruptcy and 70% of principal and interest recovered.
Risk-free rate ($r_F$) = 9%.

Expected cash flow at end year one:

$$.9(1100) + .1(.7)(1100) = 1067$$

If bankruptcy uncorrelated with general business cycle, return on bond will be independent of return on diversified portfolio. By CAPM, $r_F$ is appropriate discount rate and bond value is:

$$P = \frac{1067}{1.09} = 978.90$$

"Promised" yield:

$$\frac{1100}{978.90} - 1 = 12.37\%$$

| Default Probability | Promised Yield | |
|---|---|---|
| .1 | 12.37% | |
| .2 | 15.96% | expected |
| .3 | 19.78% | return = 9% |

WHARTON REPROGRAPHICS

5

# EFFICIENT CAPITAL MARKETS AND CAPITAL STRUCTURE

# THE EFFICIENT MARKETS HYPOTHESIS (EMH)

EMH: "Securities are correctly priced."

What does it mean for securities to be correctly priced?

# EFFICIENCY OF MARKETS IN REAL VS. FINANCIAL ASSETS—AN EXAMPLE

Company X announces it will open a plant to produce a new product next year (assume NPV $> 0$).

In an efficient market, what will happen to the price of shares in company X?

EMH: "Current prices reflect available information."

## 3 Basic Tests of Market Efficiency:

1. Cycles (Weak Form Tests)
2. Event Studies (Semi-strong Form Tests)
3. Performance of Money Managers (Strong Form Tests)

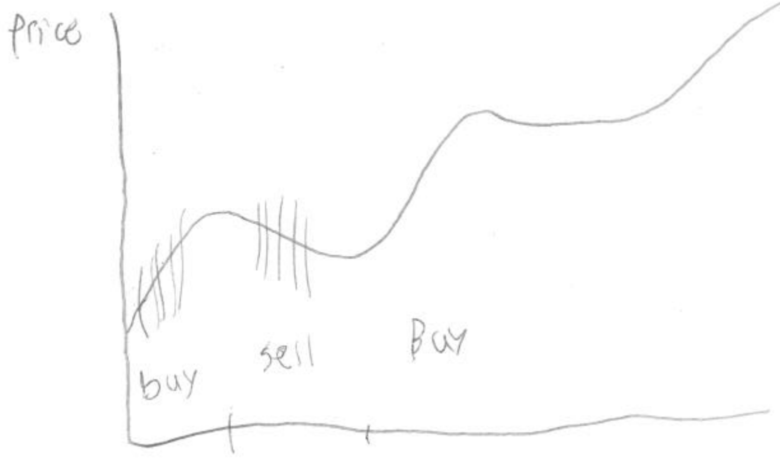
$$P_t = P_{t-1} + \underset{\text{trend}}{\underset{\uparrow}{\theta}} + \underset{\substack{\text{random}\\ \text{Error}}}{\underset{\uparrow}{\epsilon}}$$

↖ unanticipated component of News

Random walk = Weak Form

= past prices don't help you figure out future prices.

# CYCLES IN THE DATA

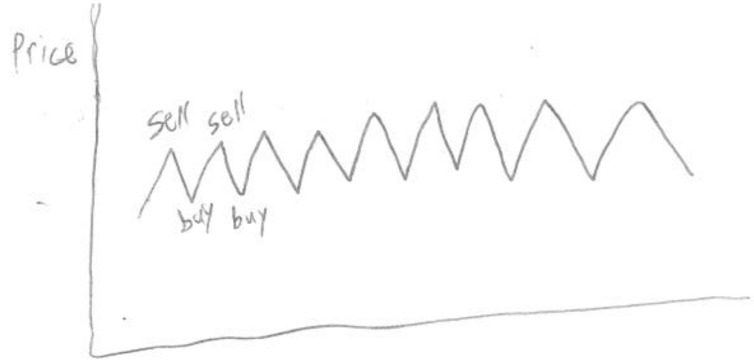


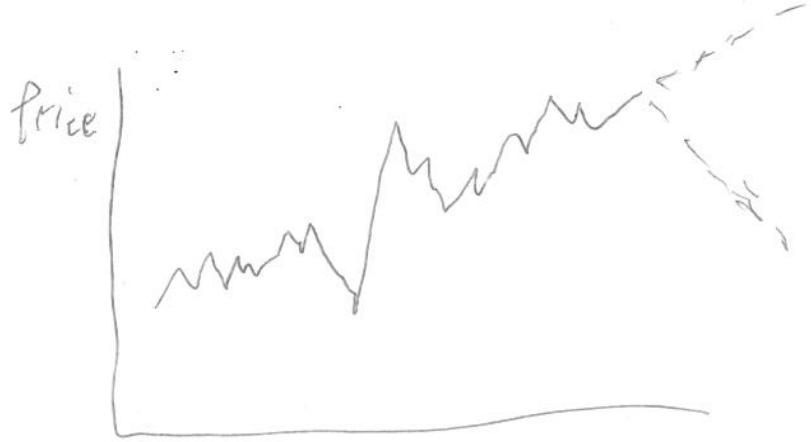
Positive serial correlation

tendency towards continuation

Negative serial correlation

tedency towards reversal





Randomness Doesn't Look Random.

Far from a proof of market irrationality, randomly evolving stock prices are the necessary consequence of intelligent investors competing to discover relevant information on which to buy or sell stocks before the rest of the market becomes aware of that information.

Don't confuse randomness in price *changes* with irrationality in the *level* of prices. If prices are determined rationally then only new information will cause them to change. Therefore, a random walk would be the natural result of prices that always reflect all current knowledge. Indeed, if stock price movements were predictable, that would be damning evidence of stock market inefficiency, because the ability to predict prices would indicate that all available information was not already reflected in stock prices. Therefore, the notion that stocks already reflect all available information is referred to as the efficient market hypothesis (EMH).[3]

### *Competition as the Source of Efficiency*

Why should we expect stock prices to reflect "all available information"? After all, if you are willing to spend time and money on gathering information, it might seem reasonable that you could turn up something that has been overlooked by the rest of the investment community. When information is costly to uncover and analyze, one would expect investment analysis calling for such expenditures to result in an increased expected return. This point has been stressed by Grossman and Stiglitz.[4] They argue that investors will have an incentive to spend time and resources to analyze and uncover new information only if such activity is likely to generate higher investment returns. Therefore, in market equilibrium it makes sense that efficient information-gathering activity should be fruitful. Although we would not, therefore, go so far as to say that you absolutely cannot come up with new information, it still makes sense to consider the competition.

Consider an investment management fund currently managing a $5 billion portfolio. Suppose that the fund manager can devise a research program that could increase the portfolio rate of return by 1⁄10th of 1 percent per year, a seemingly modest amount. This program would increase the dollar return to the portfolio by $5 billion × .001, or $5 million. Therefore, the fund would be willing to spend up to $5 million per year on research to increase stock returns by a mere 1⁄10th of 1 percent per year. With such large rewards for such small increases in investment performance, it should not be surprising that professional portfolio managers are willing to spend large sums on industry analysts, computer support, and research effort, and therefore that price changes are, generally speaking, difficult to predict.

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[3] Market efficiency should not be confused with the idea of efficient portfolios introduced in Chapter 7. An informationally efficient *market* is one in which information is rapidly disseminated and reflected in prices. An efficient *portfolio* is one with the highest expected return for a given level of risk.

[4] Sanford J. Grossman, and Joseph E. Stiglitz, "On the Impossibility of Informationally Efficient Markets," *American Economic Review* 70 (June 1980).

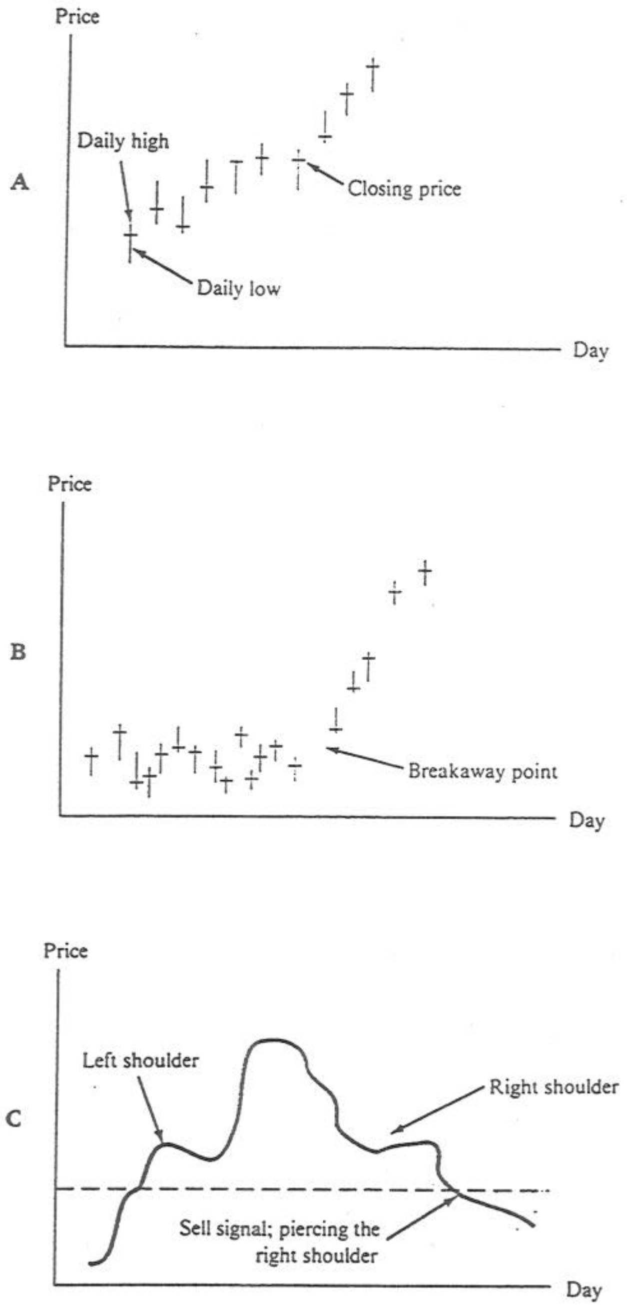


FIGURE 12.1 Technical analysis. **A**, Momentum (upward). **B**, Breakaway. **C**, Head and shoulders.

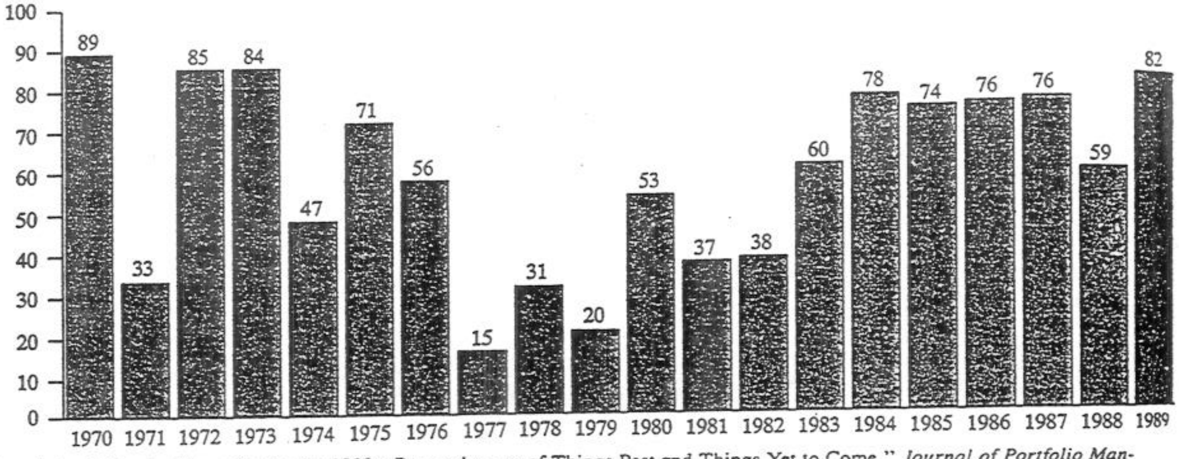
# EVENT STUDIES

Semi-strong - publicly available information included

Strong form - Efficiency → As soon as a piece of information exists, no matter how private it is, it is reflected in the stock price

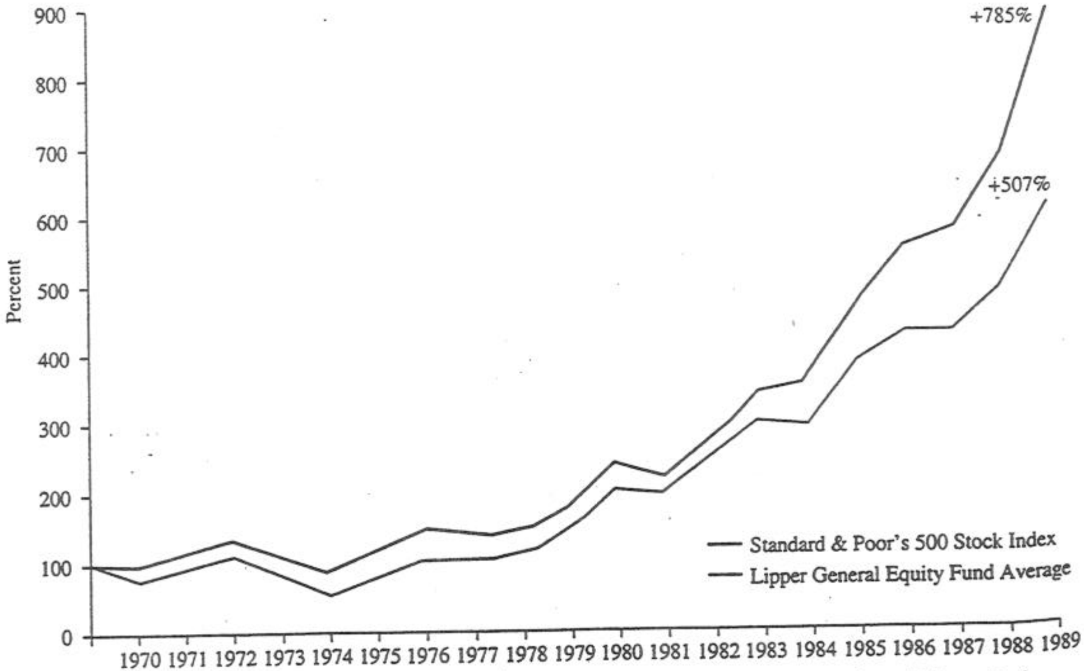
# PERFORMANCE OF MONEY MANAGERS

FIGURE 12.10 Percent of equity mutual funds outperformed by S&P 500 index.



From John C. Bogle, "Investing in the 1990s: Remembrance of Things Past and Things Yet to Come," *Journal of Portfolio Management*, Spring 1991, pp. 5–14.

FIGURE 12.11 Cumulative performance: 1970–1989.



From John C. Bogle, "Investing in the 1990s: Remembrance of Things Past and Things Yet to Come," *Journal of Portfolio Management*, Spring 1991, pp. 5–14.

Mutual Funds Do Not outperform the market (on average)

# IMPLICATIONS

Investor

P/E

P/B (B=Book Value)

Corporation

Price stock sells at is more indicative of what it's "worth" than Book Value

1:30
3:30
College Hall
102

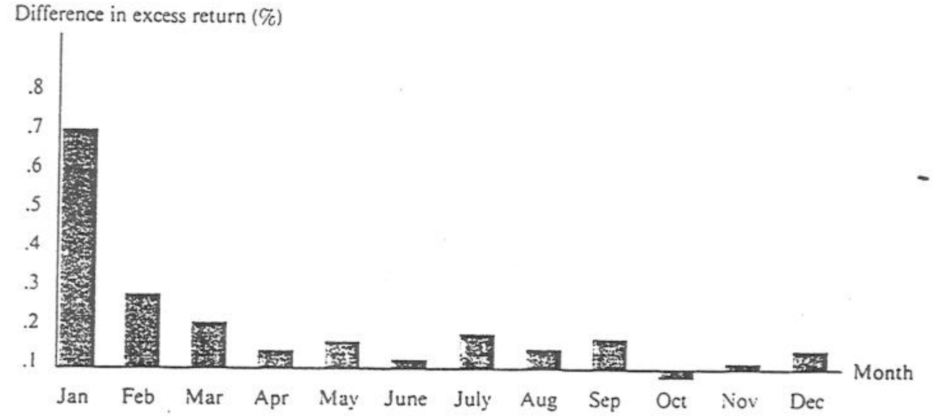
Bring
calculator

# COUNTERS TO MARKET EFFICIENCY

1. Small versus large firms

FIGURE 12.7
Average difference between daily excess returns (in percentages) of lowest-firm-size and highest-firm-size deciles for each month between 1963 and 1979.

Data from Donald B. Keim, "Size Related Anomalies and Stock Return Seasonality: Further Empirical Evidence," *Journal of Financial Economics* 12 (June 1983).



of the firm's outstanding equity. Dividing all NYSE stocks into five quintiles according to firm size, Banz found that the average annual return of firms in the smallest-size quintile was 19.8 percent greater than the average return of firms in the largest-size quintile.

This is a huge premium; imagine earning a premium of this size on a billion-dollar portfolio. Yet it is remarkable that following a simple (even simplistic) rule such as "invest in low capitalization stocks" should enable an investor to earn excess returns. After all, any investor can measure firm size at little cost. One would not expect such minimal effort to yield such large rewards.

Later studies (Keim,[22] Reinganum,[23] and Blume and Stambaugh[24]) showed that the small-firm effect occurs virtually entirely in January, in fact, in the first two weeks of January. The size effect is in fact a "small-firm-in-January" effect.

Figure 12.7 illustrates the January effect. Keim ranked firms in order of increasing size as measured by market value of equity and then divided them into 10 portfolios grouped by the size of each firm. In each month of the year, he calculated the difference in the average excess return of firms in the smallest-firm portfolio and largest-firm portfolio. The average monthly differences over the years 1963 to 1979 appear in Figure 12.7. January clearly stands out as an exceptional month for small firms, with an average small-firm premium of .714 percent per day.

The results for the first five trading days in January are even more compelling. The difference in excess returns between the smallest-firm and largest-firm portfolios for the first five trading days of the year are as follows:

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[22] Donald B. Keim, "Size Related Anomalies and Stock Return Seasonality: Further Empirical Evidence," *Journal of Financial Economics* 12 (June 1983).

[23] Marc R. Reinganum, "The Anomalous Stock Market Behavior of Small Firms in January: Empirical Tests for Tax-Loss Effects," *Journal of Financial Economics* 12 (June 1983).

[24] Marshall E. Blume, and Robert F. Stambaugh, "Biases in Computed Returns: An Application to the Size Effect," *Journal of Finance Economics*, 1983.

| Trading Day | Differential Excess Return (Average for 1963–1979) |
|---|---|
| 1 | 3.20 |
| 2 | 1.68 |
| 3 | 1.25 |
| 4 | 1.14 |
| 5 | 0.89 |
| TOTAL | 8.16 |

The total differential return is an amazing 8.16 percent over only five trading days.

Some researchers believe that the January effect is tied to tax-loss selling at the end of the year. The hypothesis is that many people sell stocks that have declined in price during the previous months to realize their capital losses before the end of the tax year. Such investors do not put the proceeds from these sales back into the stock market until after the turn of the year. At that point the rush of demand for stock places an upward pressure on prices that results in the January effect. Indeed, Ritter[25] shows that the ratio of stock purchases to sales of individual investors reaches an annual low at the end of December and an annual high at the beginning of January.

The January effect is said to show up most dramatically for the smallest firms because the small-firm group includes, as an empirical matter, stocks with the greatest variability of prices during the year. The group therefore includes a relatively large number of firms that have declined sufficiently to induce tax-loss selling.

From a theoretical standpoint, this theory has substantial flaws. First, if the positive January effect is a manifestation of buying pressure, it should be matched by a symmetric negative December effect when the tax-loss incentives induce selling pressure. Second, the predictable January effect flies in the face of efficient market theory. If investors who do not already hold these firms know that January will bring abnormal returns to the small-firm group, they should rush to purchase stock in December to capture those returns. This would push buying pressure from January to December. Rational investors should not "allow" such predictable abnormal January returns to persist. However, small firms outperform large ones in January in every year of Keim's study, 1963 to 1979.

Despite these theoretical objections, much empirical evidence supports the belief that the January effect is connected to tax-loss selling. For example, Reinganum found that, within size class, firms that had declined more severely in price had larger January returns. This pattern is illustrated in Figure 12.8. Reinganum divided firms into quartiles based on the extent to which stock prices had declined during the year. Big price declines would be expected to

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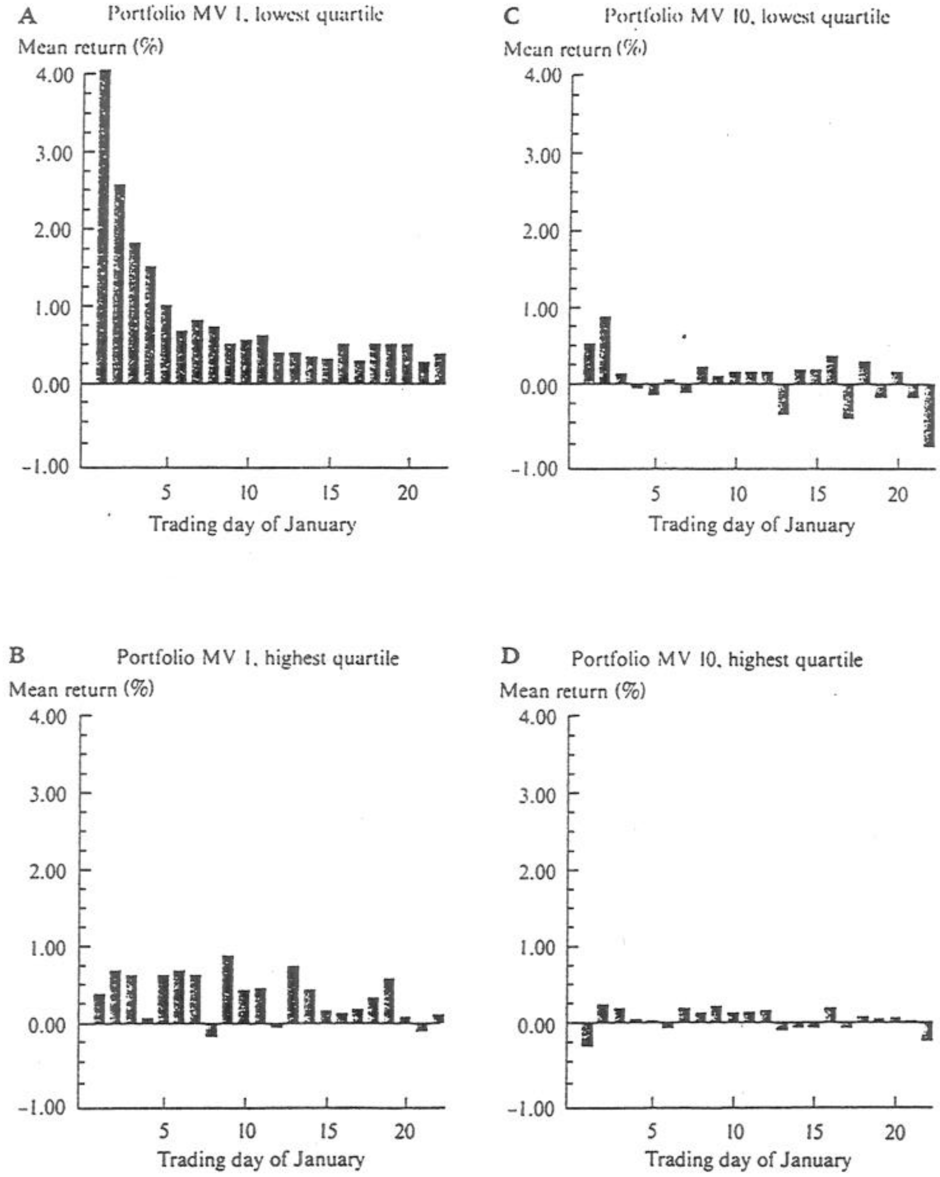
[25] Jay R. Ritter, "The Buying and Selling Behavior of Individual Investors at the Turn of the Year." *Journal of Finance* 43 (July 1988), pp. 701–17.

FIGURE 12.8
Average daily returns in January for securities in the upper quartile and bottom quartile of the tax-loss selling distribution by market-value portfolio.

From Marc R. Reinganum, "The Anomalous Stock Market Behavior of Small Firms in January: Empirical Tests for Tax-Loss Effects," *Journal of Financial Economics* 12 (June 1983).



generate big January returns if these firms tend to be unloaded in December and enjoy demand pressure in January. The figure shows that the lowest quartile (biggest tax loss) portfolios within each size group show the greatest January effect.

A size effect continues to persist, however, even after adjusting for taxes. Small firms that rose in price continue to show abnormal January returns (Figure 12.8, *B*), while large firms that declined in price show no special January effect. Hence, although taxes appear to be associated with the

## 3. Day of the Week Effect

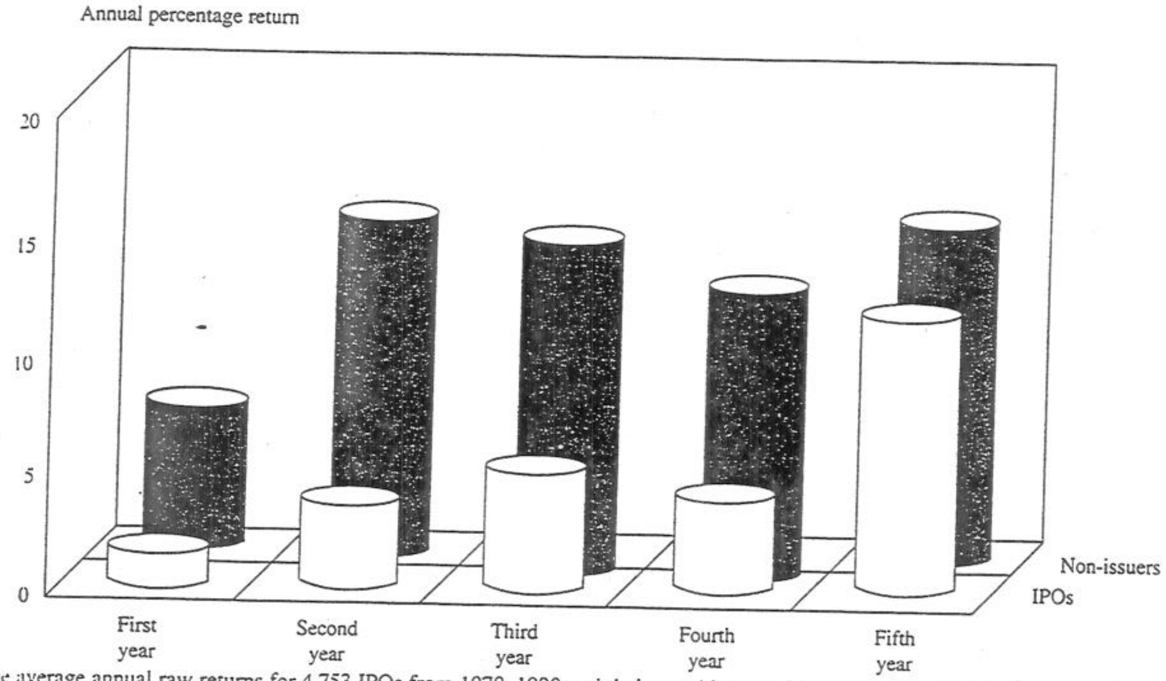
Daily return on S&P 500 (in percent)

| Mon. | Tues. | Wed. | Thurs. | Fri. |
|---|---|---|---|---|
| −.134 | .002 | .096 | .028 | .084 |

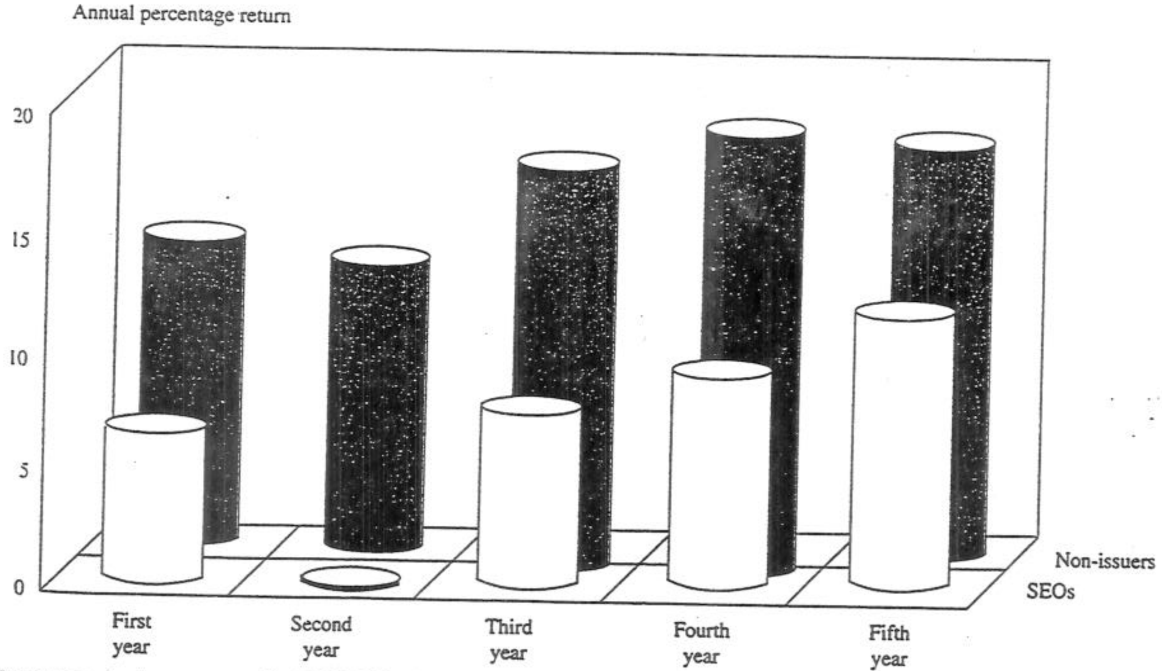
Taken from Bodie, Kane, and Marcus, p. 387

# 4. New issues

**FIGURE 13.10** Returns on Initial Public Offerings (IPOs) and Seasoned Equity Offerings (SEOs) in Years Following Issue



The average annual raw returns for 4,753 IPOs from 1970–1990 and their matching non-issuing firms during the five years after the issue. The first year return does not include the return on the day of issue.



The average annual raw returns for 3,702 SEOs from 1970–1990 and their matching non-issuing firms during the five years after the issue. On average, IPOs and SEOs underperform their control groups by 7% and 8% per year, respectively, in the five years following issuance.

See T. Loughran and J.R. Ritter, "The Timing and Subsequent Performance of New Issues," *Journal of Finance* (1995).

Warren Peter John

## 5. Buffett, Lynch and Neff

Each Made alot of Money in Market

## 6. October 19, 1987

crash

No big news that day

Reflects inefficiency that day.

6

WHARTON REPROGRAPHICS

# CAPITAL STRUCTURE WITHOUT TAXES

# THE CAPITAL STRUCTURE DECISION

The corporation's investment decision determines the operating cash flows of the firm (responsibility of Controller).

The timing and risk of these cash flows determines the value of the firm as all equity entity.

*Question:* Can any additional value be created by the choice of how the "pie is sliced?"

Financial managers (Treasurer) seek packaging of cash flows which maximizes the market value of the securities issued by corporation.

Investment Choice => Assets

Financing Decision

| Assets | Liabs & Net Worth |
|---|---|
| Fixed Assets | Equity |
| $V_U$ | $V_U$ |

| Assets | Liabs & Net Worth |
|---|---|
| Fixed Assets | Debt |
| Value of Leverage | Equity |
| $V_L$ | $V_L$ |

$V_U <, =, > V_L$ ?

## WHY TRY TO MAXIMIZE VALUE OF FIRM?

Goal of management: maximize value for shareholders.

If management succeeds in maximizing V, it maximizes E – for given investment decisions.

Example: Do shareholders gain from leverage?

1. Begin with unleveraged firm: $V_U = \$1M$ (10,000 shares @ $100/share)

2. Firm borrows $200,000 ($20/share), uses proceeds to pay dividend to shareholders. (No change in fixed assets owned by firm.)

3. If price/share > $80, shareholders benefit.

New balance sheet could be:

| Assets | Liabs & NW |
|---|---|
| Fixed Assets 1M | Debt .2M<br>Equity .8M |
| $V_U$ | $V_U$ |

*OR*

| Assets | Liabs & NW |
|---|---|
| Fixed Assets 1M | Debt .2M |
| Value of Leverage X | Equity .8M + X |
| $V_L$ | $V_L$ |

$V_L > V_U$ if leverage has value *per se*, in which case price/share > $80.

=> Maximizing value of firm <=> maximizing shareholder wealth.

## WHAT DOES "THE STREET" BELIEVE?

Looking at (total debt)/(total assets) ratios:

| IBM | Exxon | United Airlines | Citibank |
|---|---|---|---|
| 0.28 | 0.50 | 0.70 | 0.96 |

Book values – as financial analyst, need market values.

But, by any measure, dramatic inter-industry differences in leverage indicators.

Also significant intra-industry variation.

Well known industry norms.

Evidence indicates market believes value is *not* independent of capital structure.

Packaging matters.

Why?

# IMPACT OF LEVERAGE IN WORLD WITHOUT TAXES

**TRADITIONAL VIEW: Some leverage is a good thing.**

**Example:**

Firm's assets => perpetual CF = 15
All equity with $r_A = r_E = .10$

$$\Rightarrow V_U = \frac{CF}{r_A} = \frac{15}{.1} = 150$$

If, via leverage, firm can reduce $r_A$ for given CF, value rises and shareholders benefit.

$$\underset{\text{WACC}}{r_A} = \frac{D}{V} r_D + \frac{E}{V} r_E$$

"Weighted average cost of capital" (WACC) -- expected return on aggregate of the firm's securities.

All equity: $D = 0 \Rightarrow r_A = \frac{E}{V} r_E = r_E$ (E=V)

But $r_D < r_E$, debt is "cheaper."

Firm reduces WACC by adding debt if $r_E$ does not rise too drastically.

**EXTREME TRADITIONAL VIEWPOINT:** $r_E$ won't change with some debt.

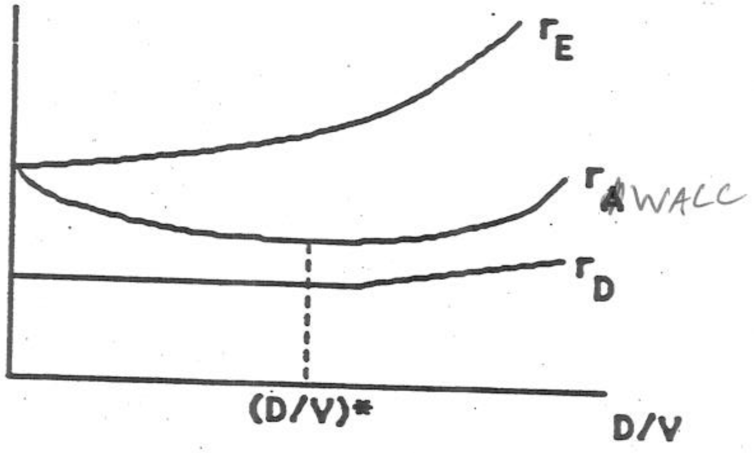
Suppose interest rate on debt is $r_D = .05$

If $r_E = .1$, $r_A$ falls and value of firm rises with indebtedness:

| D/V | $r_A$ | V |
|---|---|---|
| 0 | .10 | 150.00 |
| .10 | .095 | 157.89 |
| .20 | .09 | 166.67 |

As long as $r_E$ fixed, value increases with leverage.

**MODERATE TRADITIONAL VIEW:** $r_E$ reacts little to initial debt, but $r_E$ jumps as excessive debt levels reached:



V maximized ($r_A$ minimized) at $(D/V)^*$ -- optimal capital structure.
WACC

# EXAMPLE OF CORPORATE LEVERAGE (see BM, pg. 360-361)

**no leverage:**

TABLE 17-1

Macbeth Spot Removers is entirely equity-financed. Although it expects to have an income of $1500 a year in perpetuity, this income is not certain. This table shows the return to the stockholder under different assumptions about operating income. We assume no taxes.

DATA

| | |
|---|---|
| Number of shares | 1000 |
| Price per share | $10 |
| Market value of shares | $10,000 |

OUTCOMES

| | | | | |
|---|---|---|---|---|
| Operating income, dollars | 500 | 1000 | 1500 | 2000 |
| Earnings per share, dollars | 0.50 | 1.00 | 1.50 | 2.00 |
| Return on shares, percent | 5 | 10 | 15 | 20 |
| | | | Expected outcome | |

**with leverage, *expected* return to equity is higher:**

TABLE 17-2

Macbeth Spot Removers is wondering whether to issue $5000 of debt at an interest rate of 10 percent and repurchase 500 shares. This table shows the return to the shareholder under different assumptions about operating income.

DATA

| | |
|---|---|
| Number of shares | 500 |
| Price per share | $10 |
| Market value of shares | $5000 |
| Market value of debt | $5000 |

OUTCOMES

| | | | | |
|---|---|---|---|---|
| Operating income, dollars | 500 | 1000 | 1500 | 2000 |
| Interest, dollars | 500 | 500 | 500 | 500 |
| Equity earnings, dollars | 0 | 500 | 1000 | 1500 |
| Earnings per share, dollars | 0 | 1 | 2 | 3 |
| Return on shares, percent | 0 | 10 | 20 | 30 |
| Return on debt, percent | 10 | 10 | 10 | 10 |
| | | | Expected outcome | |

**Suppose you were absolutely *certain* that operating income will be greater than $1000. This means that EPS is *sure* to be higher with leverage.**

**Therefore, stockholders would prefer the firm with leverage, right?**

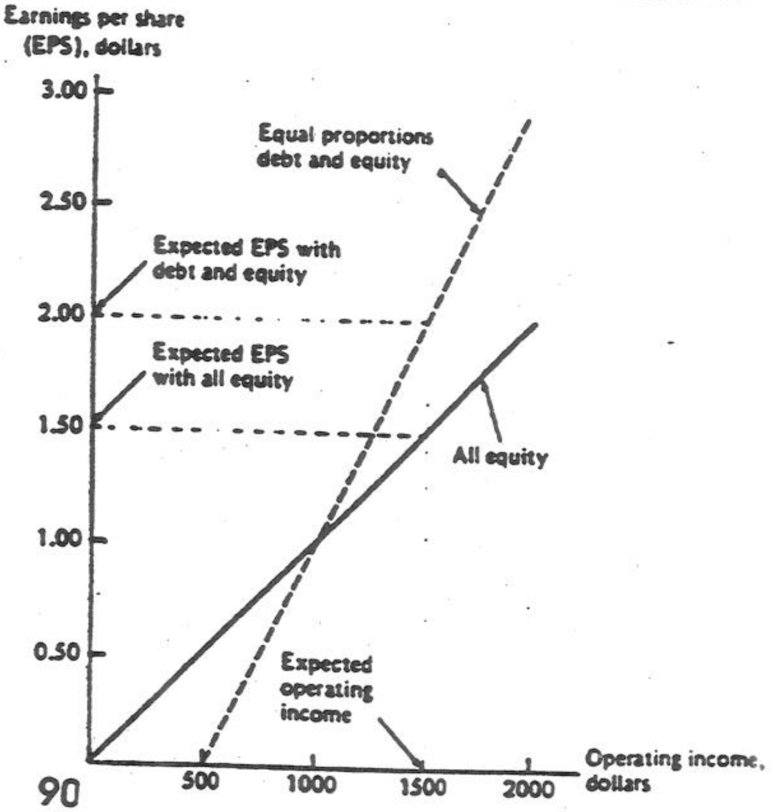


Figure 17-1 Borrowing increases Macbeth's EPS (earnings per share) when operating income is greater than $1000 and reduces EPS when operating income is less than $1000. Expected EPS rise from $1.50 to $2.

**STARTING POINT** for analysis of capital structure:

"Under what conditions are we *indifferent* to the choice of capital structure?"

## MM PROPOSITION I

If
- no transactions costs, taxes
- no costs due to financial distress
- individuals can borrow and lend on the same terms as corporations

Then
- stockholders can "undo" effects of the firm's capital structure by their personal borrowing or lending
- they won't pay a premium for shares of levered firms
- there's no "magic" in leverage
- issuing debt is a zero-NPV transaction

- $V_L = V_U$ = value of assets

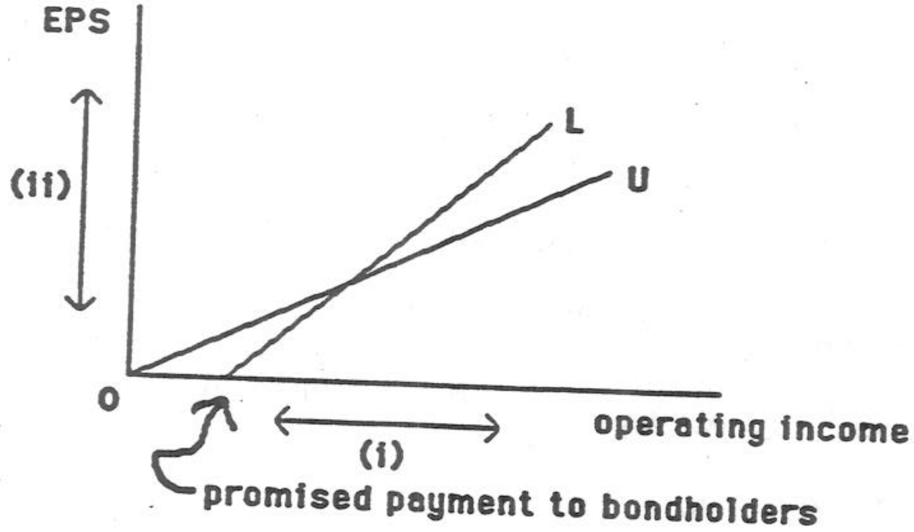
How can stockholders "undo" or "replicate" the effects of the firm's capital structure?

**TABLE 17-3**
Individual investors can replicate Macbeth's leverage.

| | OPERATING INCOME, DOLLARS | | | |
|---|---|---|---|---|
| | 500 | 1000 | 1500 | 2000 |
| Earnings on two shares, dollars | 1 | 2 | 3 | 4 |
| *Less* interest at 10 percent, dollars | 1 | 1 | 1 | 1 |
| Net earnings on investment, dollars | 0 | 1 | 2 | 3 |
| Return on $10 investment, percent | 0 | 10 | 20 | 30 |
| | | | - Expected outcome | |

"Nevertheless," you say, "whether I get the leverage on my own or through shares of a levered firm, my expected return is higher with leverage.
Leverage is *good* !"

Increased leverage creates increased risk:



(i) risk of assets is given
(ii) risk of EPS is greater with leverage
=> *required* return on equity goes up.

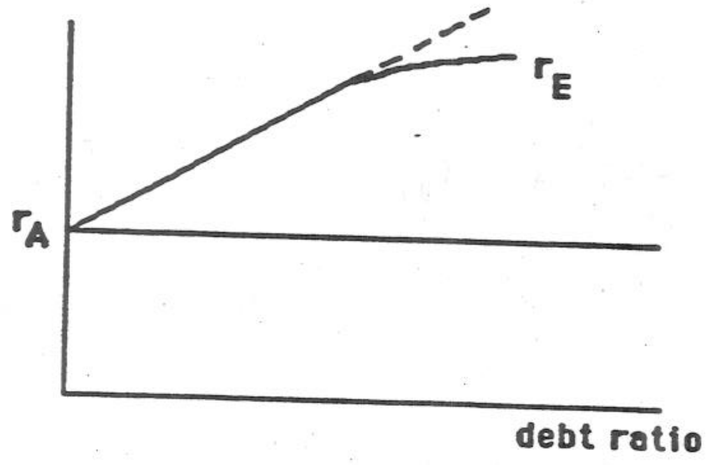
## MM PROPOSITION II

The increase in financial risk *exactly* offsets the increase in expected return (i.e., no change in firm's value).

| | |
|---|---|
| A | E |
| | D |
| $V_L$ | $V_L$ |

$$r_A = \frac{E}{D+E} r_E + \frac{D}{D+E} r_D$$

$$\Rightarrow \quad r_E = r_A + \frac{D}{E}(r_A - r_D)$$



**EXAMPLE:**

$\overline{CF}$ = expected cash flow

**All equity:**

$\overline{CF}_E = \overline{CF}_A = \$15$
$r_E = r_A = .10$

$$\Rightarrow \quad V_U = E = A = \frac{\$15}{.10} = \$150$$

| | |
|---|---|
| A=150 | E=150 |
| $V_U$=150 | $V_U$=150 |

**Levered:**

$D = \$60, \; r_D = .05$ (also perpetual)

$\overline{CF}_E = \overline{CF}_A - r_D D = \$12$

$$\text{MM I} \Rightarrow V_L = V_U = E + D \Rightarrow E = \$90$$

| | |
|---|---|
| A=150 | D=60<br>E=90 |
| $V_L$=150 | $V_L$=150 |

=> *expected* return on equity =

$$\frac{\overline{CF}_E}{E} = .133$$

$$\text{MM II} \Rightarrow r_E = r_A + \frac{D}{E}(r_A - r_D) = .133$$

**EXAMPLE:**

Firm with perpetual expected cash flow $\overline{CF} = 15$
All equity WACC $r_A = r_E = .10$
$V_U = \frac{15}{.1} = 150$

Cash flows are uncertain (=15 on average) and may be:

| State | CF |
|---|---|
| 1 | 20 |
| 2 | 10 |

$V_U = E_U = 150$

Shareholders receive full amounts, 20 or 10, depending on state if firm unleveraged.

Compare this to the same firm, i.e., one with assets offering identical cash flows, if it chooses to finance itself partially with debt.

Specifically, suppose $D = 60$
$r_D = .05$ =>interest $= .05 \times 60 = 3$

| State | CF | $r_D D$ | $CF - r_D D$ |
|---|---|---|---|
| 1 | 20 | 3 | 17 |
| 2 | 10 | 3 | 7 |

Now, the bondholders receive 3 in either state; the shareholders get 17 or 7 depending on business conditions.

$$V_L = D + E_L = 60 + E_L$$

*Question:* Does $V_L = V_U = 150$? or is $V_L > 150$?
In equity terms, does $E_L = 90$? or is $E_L > 90$?

*Answer:* In this setting, $V_L$ and $V_U$ must be the same.

To see this, think of the investor with a demand for leverage.

Individual can achieve leveraged return whether or not the firm borrows.

Case I – the firm borrows:

In this case, the investor buys the equity of the leveraged firm, and allows the corporation to create the indebtedness. Returns are:

| State | $CF - r_D D$ |
|---|---|
| 1 | 17 |
| 2 | 7 |

Case II – the firm remains all equity:

The investor must create the leverage by borrowing to finance the equity investment.

Investor buys the unleveraged equity and borrows the same amount as the leveraged firm in Case I (60).

If individual's interest cost is also 5%, returns from this strategy are:

| State | CF | $r_p D_p$ | $CF - r_p D_p$ |
|---|---|---|---|
| 1 | 20 | 3 | 17 |
| 2 | 10 | 3 | 7 |

Returns from the strategies are the same, no matter which state occurs.

Arbitrage => the investments must cost the same.

Cost of Strategy I: $E_L$ (unknown)
Cost of Strategy II: $E_U - D_p = 150 - 60 = 90$

Result: $E_L = E_U - D_p = 90$ or $V_L = E_L + D$

$V_L = E_U - D_p + D = 150 - 60 + 60 = 150$ so $V_L = V_U$

## ARBITRAGE OPPORTUNITY IF COSTS OF INVESTMENTS DIFFER

**Suppose cost of strategy I, $E_L$, is greater than 90 (say 100).**

**Whereas cost of strategy II = 90**

**(If so, $E_L > E_U - D_p$**

**& therefore, $E_L + D_p > E_U$**

**or $V_L = E_L + D > E_U = V_U$ and leverage is valuable.)**

**Why can't this be so?**

**If it were, investor would sell $E_L$ for 100, borrow 60 and buy $E_U$ for 150 (net out-of-pocket cost of 90).**

**Immediate profit of 10.**

**If State 1 occurs, cost of strategy I = CF - $r_D D$ = 20-3 = 17**
**return from strategy II = CF - $r_p D_p$ = 20-3 = 17**

**and investor uses return from long position in II to pay borrowing cost of I.**

**If State 2 occurs, return from II and cost of I = 10-3 = 7.**

**So immediate profit is risk free, independent of subsequent events.**

## KEY INGREDIENT: $r_p = r_D$

**If individuals borrow at same costs as firm, individuals will not pay premium for levered shares.**

**Can create leverage themselves on same terms.**

**Example:** **Above cash flows, but now:** $r_D = .05$ $r_p = .06$

**Case I – Firm provides leverage: Purchase of leveraged equity gives shareholder:**

| State | $CF - r_D D$ |
|---|---|
| 1 | 17 |
| 2 | 7 |

**Case II – Individual buys unleveraged equity and borrows to create same returns:**

| State | $CF - r_p D_p$ | |
|---|---|---|
| 1 | $20 - .06 D_p = 17$ | |
| 2 | $10 - .06 D_p = 7$ | as in Case I |

$\Rightarrow .06 D_p = 3$ or $D_p = 50$,

**i.e., individual borrows 50; corporation borrows 60.**

**Returns the same $\Rightarrow$ investments have same cost.**

**Cost of I:** $E_L$ (unknown)
**Cost of II:** $E_U - D_p = 150 - 50 = 100$

**Now,** $E_L = 100$ $V_L = E_L + D = 100 + 60 = 160$

$$r_p > r_D \Rightarrow V_L > V_U$$

**Individuals pay premium for shares of levered firm if corporation's interest cost is lower.**

If $r_p = r_D = .05$,

All Equity

| | | | |
|---|---|---|---|
| F.A. | 150 | E | 150 |
| $V_U = 150$ | | $V_U = 150$ | |

With Debt

| | | | |
|---|---|---|---|
| F.A. | 150 | D | 60 |
| | | E | 90 |
| $V_L =$ | 150 | $V_L = 150$ | |

But, if, e.g., $r_p = .06$ and $r_D = .05$:

All Equity

| | | | |
|---|---|---|---|
| F.A. | 150 | E | 150 |
| $V_U = 150$ | | $V_U = 150$ | |

With Debt

| | | | |
|---|---|---|---|
| F.A. | 150 | D | 60 |
| Value of Leverage | 10 | E | 100 |
| $V_L =$ | 160 | $V_L = 160$ | |

Note: $r_p$ is personal borrowing rate on margin contracts, i.e., rate charged investors posting the firm's shares as collateral.

## MM II VERSUS TRADITIONAL VIEW

**Risk of equity rises immediately with leverage**
**=> $r_E$ cannot stay at all-equity value.**

**Consider returns on equity for all-equity vs. leveraged firms, assuming:**

| State | $r_E^U$ | $r_E^L$ |
|---|---|---|
| 1 | $\frac{20}{150} = .133$ | $\frac{17}{90} = .189$ |
| 2 | $\frac{10}{150} = .067$ | $\frac{7}{90} = .078$ |
| Spread in Returns | .066 | .111 |

**Volatility of return on equity rises with leverage.**
**=> $r_E \uparrow$ and price/share $\downarrow$ if EPS stable.**

**But EPS rises with leverage, too, and net effect is that**

$$P = \frac{EPS}{r_E} \quad \text{is unaffected by leverage.}$$

## SUMMARY

If $r_p = r_D$, leverage cannot change the value of the corporation.

If $r_p > r_D$, firm's value still may not rise with debt.

What are the costs to other firms of satisfying investor demand for leverage?

If small, and finite demand, expect value created from conventional debt to be low.

WHARTON REPROGRAPHICS

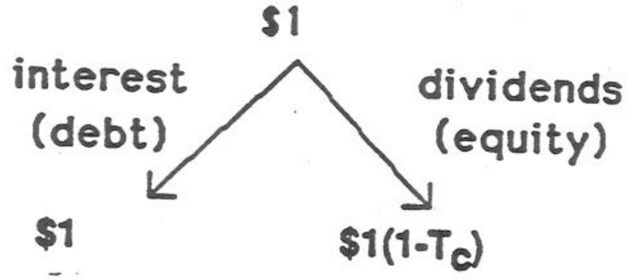
7

# CAPITAL STRUCTURE WITH TAXES

## MM AND TAXES

Corporate taxes only
(continue to assume no personal taxes).

For every dollar of cash flow generated by the assets of the corporation, the after-tax flow to investors is either:



Fact that interest is deductible from corporate income for tax purposes => *packaging matters.*

Expect V ↑ with leverage since CF to investors rises due to interest tax shield.

Specifically, reduce tax each year by:

$T_C r_D D_L$

annual interest payment

# INTUITIVE APPROACH TO CAPITAL STRUCTURE ISSUES

When is $V_L > V_U$ ?

1. Does leverage increase the after-tax CF to bond and stockholders together?

   If so, value of securities issued by the firm rises with indebtedness.

   If $T_c > 0$ & $T_p = 0$, packaging cash flows as interest to bondholders raises overall CF.

2. Does the corporation borrow more cheaply than the individual in after-tax terms?

   With no taxes, $r_p \overset{?}{=} r_D$

   If $r_p > r_D$, $V_L > V_U$

   With $T_c > 0$ & $T_p = 0$, even with before-tax costs the same ($r_p = r_D$),

   $r_D(1-T_c) < r_p \implies V_L > V_U$

## EXAMPLE FROM DAY 4 – $T_C = .4$

## CASH FLOWS TO INVESTORS:

**All equity firm:**

| State | CF | $CF(1-T_C)$ |
|---|---|---|
| 1 | 20 | 12 |
| 2 | 10 | 6 |

**Leveraged firm (D = 60):**

| State | CF | $r_D D$ | $CF - r_D D$ | $(CF-r_D D)(1-T_C)$ |
|---|---|---|---|---|
| 1 | 20 | 3 | 17 | 10.2 |
| 2 | 10 | 3 | 7 | 4.2 |

## CASH FLOW TO STOCKHOLDERS IF ALL EQUITY:

| State | $CF(1-T_C)$ |
|---|---|
| 1 | 12 |
| 2 | 6 |

## CASH FLOW TO STOCKHOLDERS AND BONDHOLDERS IF LEVERAGED:

| State | $(CF-r_D D)(1-T_C)+r_D D$ |
|---|---|
| 1 | 10.2 + 3 = 13.2 |
| 2 | 4.2 + 3 = 7.2 |

difference = 1.2 for both states

## EXAMPLE FROM DAY 4 (cont'd)

Total cash flow to investors ↑ by 1.2 in each state.

$1.2 = T_C r_D D = .4\ (.05)\ 60,$ the annual tax shield.

Difference in cash flows to investors:

$$(CF - r_D D)(1-T_C) + r_D D - CF(1-T_C) = T_C r_D D$$

This is the annual tax savings and increase in cash flow into investors' pockets.

Increase in value of corporation is present value of each year's savings:

$$PVTS = \frac{T_C r_D D}{1+r_D} + \frac{T_C r_D D}{(1+r_D)^2} + \ldots = \frac{T_C r_D D}{r_D} = T_C D$$

$$\text{Here } = \frac{.4\ (.05)\ 60}{.05} = 24$$

$$V_L = V_U + T_C D$$

$$\frac{\overline{CF}\ (1-T_C)}{r^U_E} + T_C D$$

$$= \frac{15\ (1-.4)}{.1} + .4\ (60)$$

$$= 90 + 24 \qquad = 114$$

# MM PROPOSITION II WITH CORPORATE TAXES

Corporation's portfolio of assets and liabilities:

| Leveraged | |
|---|---|
| FA | D |
| PVTS=$T_cD$ | E |
| $V_L$ | $V_L$ |

Calculate weighted average return to assets and liabilities:

$$\left(\frac{FA}{V_L}\right) r_A + \left(\frac{T_cD}{V_L}\right) r_D = \left(\frac{D}{V_L}\right) r_D + \left(\frac{E}{V_L}\right) r_E$$

$$\Rightarrow r_E = r_A + \frac{D}{E}(1-T_c)(r_A - r_D)$$

Required return on equity rises more slowly with leverage.

With EPS rising as before, slower increase in $r_E$ =>

$$P = \frac{EPS}{r_E} \uparrow$$

WHARTON REPROGRAPHICS 8

# ADJUSTED PRESENT VALUE, WEIGHTED AVERAGE COST OF CAPITAL, AND FLOWS TO EQUITY

# VALUING A LEVERED CORPORATION

**Method 1: Adjusted Present Value (APV)**

$$\underbrace{V_L}_{\substack{\text{market value}\\\text{of levered}\\\text{firm}}} = \underbrace{V_U}_{\substack{\text{market value}\\\text{of all-equity}\\\text{firm}}} + \underbrace{NPVF}_{\substack{\text{value created}\\\text{by financing}\\\text{side effects}}}$$

What are "financing side effects"?

- net value tax shields of debt supported by the firm (PVTS)
- costs of issuing new securities
- costs of financial distress

# VALUING A LEVERED CORPORATION - THE APV APPROACH

PB SINGER INC.

Sales: \$100M/yr, stable indefinitely
Cash costs: 1/3 of sales
Dep'n = Investment in P&E = \$25M/yr
$T_C = 40\%$ $r_A = 20\%$

*STEP 1: VALUE THE ALL-EQUITY (UNLEVERED) FIRM*

Unlevered free cash flows are:

| | |
|---|---|
| Sales | 100.0 |
| Cash costs | 33.3 |
| Depreciation | 25.0 |
| Operating income | 41.7 |
| Corporate tax | 16.7 |
| AT operating income | 25.0 |
| Depreciation | 25.0 |
| Inv. in P&E | 25.0 |
| Unlevered FCF | 25.0 |

Using discount rate of 20%, the value of the firm is:

$$V_U = \frac{25}{.2} = 125.$$

## APV APPROACH TO VALUING THE LEVERED FIRM (cont'd)

**PB SINGER (cont'd)**

*STEP 2: ADD THE VALUE OF THE DEBT*

Suppose firm sets target D/V ratio of 30%.

Value of this firm, adding debt tax shields, will now be:

$$V_L = V_U + T_C D$$

$$= 125 + .4\,[(.3)\ V_L]$$

Therefore,

$$V_L\ [1-(.4)(.3)] = 125$$

$$\Rightarrow V_L = 142.0$$

## TAX SHIELD AND ANNUAL CASH FLOW

Calculate impact on Singer's financial statements:

$$D = .3\,(V_L) = .3\,(142.0) = 42.6$$

Suppose, e. g., $r_D = 11\%$. Then annual interest cost is:

$$r_D D = .11\,(42.6) = 4.7$$

The levered firm's income/cash flow statement is now:

| | |
|---|---:|
| Sales | 100.0 |
| Cash costs | 33.3 |
| Depreciation | 25.0 |
| Interest | 4.7 |
| Operating income | 37.0 |
| Corporate tax | 14.8 |
| AT operating income | 22.2 |
| Depreciation | 25.0 |
| Inv. in P&E | 25.0 |
| Levered FCF | 22.2 |

# TAX SHIELD AND ANNUAL CASH FLOW (cont'd)

Free cash flow was 25 when firm was all-equity (all to stockholders).

Total payout to investors in *levered* firm is:

$$22.2 + 4.7 = 26.9$$

Difference is 26.9-25 = 1.9, the same as:

$$T_c r_D D = .4(.11)42.6 = 1.9$$

This raises firm's value by:

$$PVTS = T_c D = .4(42.6) = 17.0.$$

## CHANGE IN SINGER'S BALANCE SHEET

**If markets are efficient, stock price reflects value of tax shields as recapitalization is announced.**

**1. Simplified Pre-Recapitalization Balance Sheet:**

SINGER INC.
(All-Equity)

| Assets | | Liabs & SE | |
|---|---|---|---|
| P&E (Vu) | 125 | Equity | 125 |

**Firm is valued as all-equity entity.**

**2. Firm announces recap plan, and market revalues equity:**

SINGER INC.
(Announces Recap Plan)

| Assets | | Liabs & SE | |
|---|---|---|---|
| P&E (Vu) | 125 | Equity | 142 |
| Value of Leverage | 17 | | |

*Share price rises to $142M/10M = $14.20*

**Market 'discounts' tax shield; stock reflects value of leverage.**

## CHANGE IN SINGER'S BALANCE SHEET (cont'd)

3. **Firm issues debt, collects cash proceeds:**

**SINGER INC.**
**(Issues Debt)**

| Assets | | Liabs & SE | |
|---|---|---|---|
| Cash | 42.6 | Debt | 42.6 |
| P&E (Vu) | 125 | Equity | 142 |
| Value of Leverage | 17 | | |

**First step in implementation of debt-for-equity swap.**

4. **Firm uses cash to repurchase shares:**

**SINGER INC.**
**(Equity Retired)**

| Assets | | Liabs & SE | |
|---|---|---|---|
| P&E (Vu) | 125 | Debt | 42.6 |
| Value of Leverage | 17 | Equity | 99.4 |

*Firm retires*
*$42.6M/$14.20 = 3M shares,*
*leaving 10M-3M=7M outstanding*

**Tender offer or open market purchase.**

## VALUING A LEVERED CORPORATION

### Method 2: Valuing the Equity, Summing in Debt Value

To value equity, need earnings per share and required equity return.

1. Cash flow to stockholders ($C_E$):

$$C_E = (X - r_D D)(1 - T_C) - \text{debt principal payment.}$$

2. Required return on equity:

Market Value Balance Sheet

| Assets | Liabs & NW |
|---|---|
| Fixed Assets | Debt |
| PVTS = TcD | Equity |
| Value | Value |

Calculate weighted average return to assets and liabilities:

$$\left\{\frac{FA}{V_L}\right\} r_A + \left\{\frac{T_C D}{V_L}\right\} r_D = \left\{\frac{D}{V_L}\right\} r_D + \left\{\frac{E}{V_L}\right\} r_E$$

$$\Rightarrow \boxed{r_E = r_A + \frac{D}{E}(1 - T_C)(r_A - r_D)}$$

## APPLYING METHOD 2 - SINGER INC.

1. **Cash flow to Singer stockholders: $22.2M**

   **(Debt assumed constant so no principal payment)**

2. **Required return on equity:**

$$r_E = .20 + \frac{3}{7} (1-.40)\ (.20-.11)$$

$$= .223.$$

**Value of total equity outstanding is therefore:**

$$E_L = \frac{\$22.2M}{.223} = \$99.4M.$$

**Adding the debt of $42.6M, we value firm at $142M as before.**

## TRADEOFF BETWEEN EPS AND SHAREHOLDER RISK

Common justification given to shareholders to agree to increase in leverage:

"Transaction will raise earnings per share"

Expected payout per share will rise with debt.

Example: SINGER INC.

| | All-equity firm | Levered firm |
|---|---|---|
| Earnings/share | $\frac{\$25M}{10M} = \$2.50$ | $\frac{\$22.5M}{7M} = \$3.21$ |

But, as Macbeth Spot Removers illustrates, financial leverage simultaneously increases shareholder risk and required return:

| | All-equity firm | Levered firm |
|---|---|---|
| Required equity return | .20 (= $r_A$) | .223 |

With tax benefit of debt, increase in EPS exceeds rise in $r_E$, and share price rises with leverage.

# VALUING A LEVERED CORPORATION (cont'd)

**Method 3: Weighted Average Cost of Capital (WACC)**

Value the firm by discounting the *unlevered* free-cash flows by WACC:

$$V_L = \Sigma \frac{C_t}{(1+r_{WACCt})^t}\ .$$

What is the weighted average cost of capital?

$$r_{WACC} = \frac{D}{V} r_D\ (1-T_C) + \frac{E}{V} r_E.$$

If use $r_E$ from Method 2, get:

$$r_{WACC} = r_A \left[1-T_C\left(\frac{D}{V}\right)\right].$$

# APPLYING METHOD 3 - SINGER INC.

1. **Unlevered free cash flow: $25M**

2. **Weighted average cost of capital:**

$$r_{WACC} = .20\left[1-.40\,(.30)\right].$$

$$= .176.$$

**Value of company is therefore:**

$$V_L = \frac{\$25M}{.176} = \$142M.$$

## PROS AND CONS OF DIFFERENT METHODS

As usually applied, the methods give same answers *only* when:

- asset cash flows are a perpetuity
- debt level is also constant

## WACC APPROACH HAS ITS ADVANTAGES. . .

- Can use market returns to estimate $r^*$
- Simpler calculation for given cash flow estimates

## BUT ALSO DISADVANTAGES

- Risk and debt/equity blend of firm must be stable (or must adjust WACC over time)
- Still, difficult to estimate $r_E$

## PROS AND CONS (cont'd)

While all three methods give correct answer when properly used, more convenient to use:

- WACC if capital structure (D/V) is stable over foreseeable future;
- APV if D/V is changing but dollar amount of debt outstanding is predictable.

Examples:

*Recapitalization*

Firm issues debt and retires shares, usually with intent to maintain higher leverage. If target D/V is stable, easiest to value firm with constant WACC.

*LBO or Project Finance*

Recapitalized firm (or project) begins with excessive debt. Intent is to reduce principal over time to target. Result: D/V expected to fall.

APV 'works' under recap, but WACC is more direct.

WACC fails in LBO, unless $r_E$ and $r_{WACC}$ are appropriately adjusted to take change in financing mix into account.

# A RECAPITALIZATION EXAMPLE

Fast Foods, Inc.

Projected '95 sales: \$75M Sales grth (yrs 1–3): 12%
Cash costs: 60% sales Tax rate: 34%
Target D/V: 40% $r_A$: 18% $r_D$: 9%

Depreciation matched by investment in P&E. \$10M in '95, growing at 12% for the next two years.

Working capital needs: 10% sales.

Unlevered free cash flows grow at 6% after 1997.

Question:

1. What is the value of FFI as an all-equity firm?
2. Determine its value if it immediately implements its debt/equity target.

(Work Space)

## AN LBO EXAMPLE

Smoky Glass Co. is an all-equity firm with stable, before-tax sales less cash costs of $25M/yr. New investment in P&E just matches equipment depreciation of $8.5M/yr. The firm pays corporate tax at a rate of 40%, and the required return on its (unlevered) equity is 18%.

*Question:*

1. Calculate the fair market value for Smoky in its current all-equity form.

## LBO EXAMPLE (cont'd)

Management approaches the board with a plan to take the firm private in an LBO. The managers feel they could raise net sales at a 10% annual rate over the next three years, after which revenue would be flat at the new level. They plan to offer $85M for the company, paid for with equity of $10M and a loan from Chemical of $75M. The terms of the loan are:

a) principal payments of $5M/yr for first 3 years,
b) remaining principal due at end third year,
c) interest rate of 14%.

At the end of the third year, management plans to take the firm public again. The new management is expected to finance the company with a 1:1 debt:equity mix. At this blend, the firm could borrow at the lower rate of 11%.

*Questions:*

2. Calculate the unlevered value of Smoky under management's projections?

3(a). What is the APV of the deal if management is able to buy the firm for $85M?

3(b). What is the rate of return to the managers if they are able to buy the firm for $85M, and can sell as planned after three years?

4. What is the maximum price management should be willing to pay for the company?

5. Would you lend the managers the $75M?

(Work Space)

(Work Space)

9

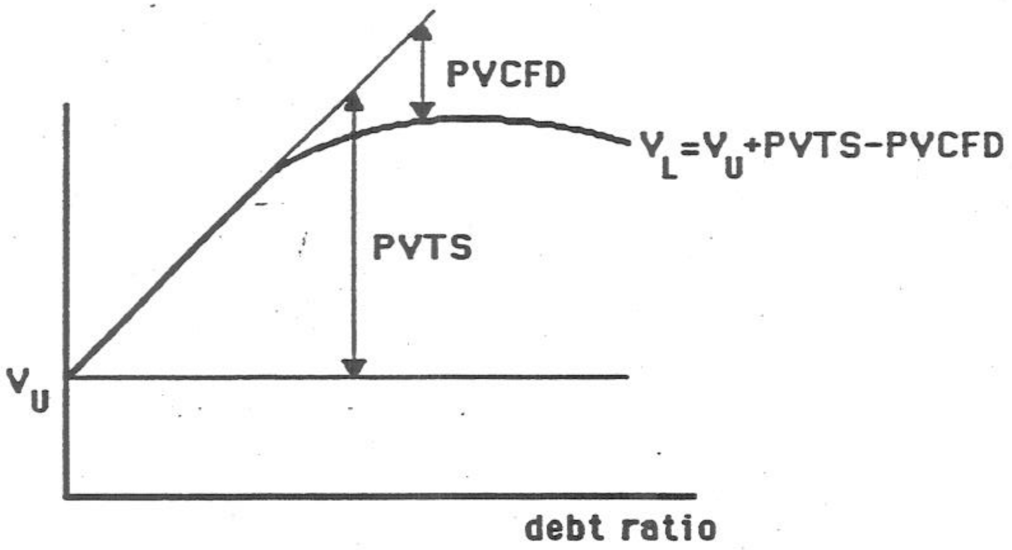
WHARTON REPROGRAPHICS

# COSTS OF DEBT AND OPTIMAL CAPITAL STRUCTURE

# OTHER FACTORS INFLUENCING CAPITAL STRUCTURE

## I. *Costs of Financial Distress (CFD)*

**If PVTS adds value to the firm, what prevents firms from going to 99% debt?**



**What exactly do we mean by CFD?**

**These are any costs due to the *possibility* of bankruptcy, and include:**

- **direct costs, incurred when the firm is *in* bankruptcy**
- **indirect costs, incurred *before* bankruptcy**

## DIRECT COSTS OF BANKRUPTCY

- Legal and accounting fees.
- How good is secondary market for firm's assets?
- Costs will be high if much of value from reputation, expected future technological breakthroughs, human capital.

## INDIRECT COSTS

- Restricted dealings with customers, suppliers, creditors.
    - fear of discontinued operations (Penn Central, Osborne)
- Reduced value due to conflicts of interest among security holders.
    - near bankruptcy, equity holders prefer riskier investments => increases risk of the debt, transfers existing corporate value from bondholders to stockholders
    - => mismanagement of existing assets & underinvestment in NPV > 0 projects
    - equityholders also want dividends, salvage what value they can leaving bondholders with less

# ILLUSTRATION OF CFD

Example 1: Firm has $10M. It owes bondholders $20M in principal and interest due in 1 year.

Management must choose between:

1. Paying $10M dividend
2. Investing funds in project with certain payoff in 1 year of $20M.

If it pays the dividend, what are payoffs to bond- and stockholders now, and in 1 year?

| Dividend | $C_0$ | $C_1$ |
|---|---|---|
| Payoff to stkhldrs: | 10 M | 0 |
| Payoff to bdhldrs: | 0 | 0 |

If it invests in project, what are payoffs to bond- and stockholders now, and in 1 year?

| INvest | $C_0$ | $C_1$ |
|---|---|---|
| Payoff to stkhldrs: | 0 | 0 |
| Payoff to bdhldrs: | 0 | 20 M |

## ILLUSTRATION OF CFD (cont'd)

*Given the payoffs under the two plans,*

which plan will bondholders prefer?

Invest

which plan will stockholders prefer?

Pay out Dividend

*Result* : The conflict between bond- and shareholders may lead the firm to forego positive NPV projects.

What restriction will bondholders want to place on the firm's actions? Under what conditions?

## ILLUSTRATION OF CFD (cont'd)

Bondholders want to write covenant into loan prohiting dividends when firm is in distress

Example 2: Suppose such covenants are present. Firm, as before, owes $20M to bondholders in 1 year. Firm must choose between two projects:

| | $C_0$ | $C_1$ | |
|---|---|---|---|
| A | -10 | 20 | (certain) |
| B | -10 | 40<br>(or)<br>0 | (two possible outcomes) |

If firm chooses the risky project, what are payoffs to bond-and stockholders now, and in 1 year?

| | $C_0$ | $C_1$ | |
|---|---|---|---|
| | | G | B |
| Payoff to stkhldrs: | | 20 | 0 |
| Payoff to bdhldrs: | | 20 | 0 |

## ILLUSTRATION OF CFD (cont'd)

*Given choice between projects,*

which plan will bondholders prefer?

which plan will stockholders prefer?

*Result* : Even with covenants to restrict dividends, bond- and stockholders may disagree on project choice.

What restriction will bondholders want to place on the firm's actions? Under what conditions?

# WHO BEARS POTENTIAL COSTS OF FINANCIAL DISTRESS

Bondholders recognize possibility that these costs will be incurred.

Discount price of firm's bonds accordingly.

=> Stockholders bear the costs -- reduction in value -- from potential future bankruptcy.

Helps explain *restrictive covenants* in debt contract:

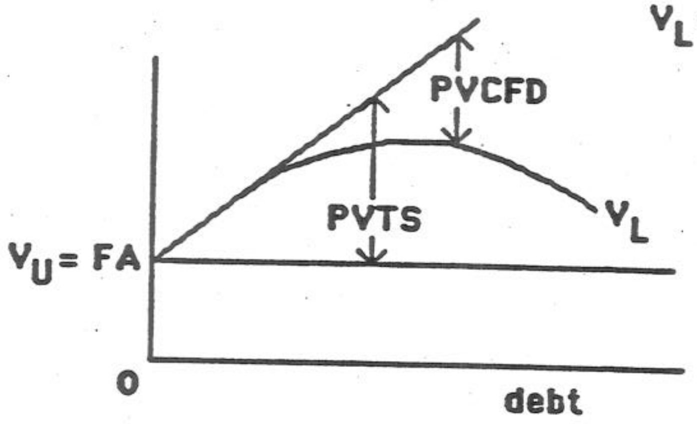
- dividends
- sale of assets
- new debt (and leases)

*Question:* Who benefits from these covenants,
bondholders or stockholders?

# SUMMARIZING CFD AS TEMPERING INFLUENCE ON LEVERAGE

When will CFD be *high* ?

- when *current* cash flows are reduced by possibility of bankruptcy
- when assets are lost during bankruptcy (e.g., reputation, human capital)
- when much of value depends on discretionary future investments (e.g., high tech R&D)
- when assets generate volatile earnings (raises probability of bankruptcy)
- when risk of assets can be shifted easily (e.g., financial companies)



$V_L = V_U + PVTS - PVCFD$

## BLENDING TAXES AND CFD

A firm's financing decision is affected by its risk

Risk is primarily a function of 3 factors:

1) Sales fluctuation
2) Operating Leverage

}Business Risk -

3) Financial Leverage

Operating Leverage - The extent to which the firm is subject to fixed costs in its production

Consider the differences between technology A and Technology B

Technology A
Price = $10/unit
Fixed Cost = $1,000/year
Variable Cost = $8/unit

Technology B
Price = $10/unit
Fixed Cost = $2,000/year
Variable Cost = $6/unit

Which technology is more risky?

# THE CORPORATE BALANCE SHEET

No "easy answers" on capital structure but:

- inter-industry debt ratios indicate there is an optimal range for different types of assets.
- intra-industry debt ratios indicate the range is quite broad.

| INDUSTRY | EQUITY |
|---|---|
| Aerospace | 71.0 |
| Airlines | 28.6 |
| Appliances | 60.1 |
| Automotive | 60.6 |
| Beverages | 65.9 |
| Building Materials | 51.0 |
| Chemicals | 62.2 |
| Conglomerates | 50.2 |
| Containers | 58.9 |
| Drugs | 76.8 |
| Electrical/Electronics | 74.7 |
| Food Processing | 67.3 |
| Food & Lodging | 51.4 |
| General Machinery | 75.3 |
| Instruments | 78.2 |
| Leisure Time Ind | 75.9 |
| Metals & Mining | 60.6 |
| Misc. Manufacturing | 68.2 |
| Natural Resources | 67.2 |
| Office Equip. & Computers | 75.1 |
| Oil Service | 67.0 |
| Paper Products | 61.8 |
| Personal Care Products | 75.3 |
| Publishing, Radio, TV | 70.4 |
| Railroads | 63.6 |
| Real Estate & Housing | 50.2 |
| Retailing (food) | 52.5 |
| Retailing (non food) | 55.0 |
| Service (leasing, vending, medical) | 41.1 |
| Special machinery | 62.9 |
| Steel | 48.4 |
| Textiles-apparel | 71.5 |
| Tires & Rubber | 66.6 |
| Tobacco | 58.4 |
| Trucking | 67.2 |
| Utilities | 44.5 |
| Composite | 58.5 |

## OTHER FACTORS INFLUENCING CAPITAL STRUCTURE (cont'd)

### II. *Agency Costs*

Recall corporate organizational chart of Day 1.

Stockholders *elect* Board of Directors *choose* Managers

In publicly held firms,

- weak monitoring of management decisions by shareholders
- if conflict between goals of owners and managers, managers follow own agenda

Leads to deviation from maximization of shareholder value:

- managers invest in 'pet' projects
- 'perks' for executives and board members

# AGENCY COSTS AND CAPITAL STRUCTURE

*How does this affect financing mix for firm?*

'Bonding' the managers:

Fix capital structure to pre-empt misuse of free cash flows

High debt levels force firm to distribute cash generated to debt service

Eliminates management discretion

But, by tying management's hands, makes funding positive APV investments more difficult

## LBOs AND FACTORS INFLUENCING CAPITAL STRUCTURE

Above reasoning suggests that LBOs:

- offer firms significant tax shields
- reduce agency costs
- raise CFD as debt levels climb

*How do LBOs reduce agency costs?*

- managers and board members assume significant ownership stake
- 'bonding' in extreme, with most cash flow dedicated to debt service

*But how to deal with CFD that accompany excessive debt?*

- Going private reduces number of security holders that must agree to 'work-out' terms

  Reduces probability of bankruptcy and costs if firm must be re-organized

- 'Strip financing' often used to eliminate conflicts between bond- and stockholders

# LBOs AND FACTORS INFLUENCING CAPITAL STRUCTURE (cont'd)

Suggests characteristics of ideal LBO candidates:

- Stable cash flow to reduce chance of difficulty servicing debt
  - also maximizes value of tax shield
- 'Cash cow' with little need for new discretionary investment or R&D
  - impossible with excessive debt service
- Tangible, salable assets in case performance falls below projections

# SUMMARY

1. Other factors influencing capital structure:
   - Cost of financial distress
   - Agency costs

2. Characteristics of an ideal LBO candidate.
   - Stable cash flow
   - Minimum discretionary investment or R & D required
   - Tangible, salable assets

10

WHARTON REPROGRAPHICS

# ALTERNATIVE VALUATION METHODS

# PURPOSES OF VALUATION

## MERGERS AND ACQUISITIONS

Need 'theoretical value' to compare to market price

*Buyer perspective*

- efficiencies, synergies, refinancing
- minority interest or control
  (premium to acquire control)
- determine maximum price willingly paid

*Seller perspective*

- assess likelihood of success of defensive strategies
- determine maximum price buyer should pay
  (maximize gains for stockholders)

## VALUING A PRIVATE COMPANY

Acquisition by other firm

Initial public offering

# BRIEF REVIEW OF DCF APPROACHES

## I. FREE CASH FLOW DISCOUNT MODEL (WACC)

*Necessary Ingredients*

A. Projected cash flows

Sales
- Cash costs of sales
- Non-cash charges

= Earnings before interest & taxes (EBIT)
- Taxes on EBIT

= EBIAT
+ Non-cash charges

= Gross cash flow
- Investments into:
Plant & equipment
Net working capital

= Unlevered free cash flows

B. Terminal value (Total firm, not just equity)

## DCF REVIEW - WACC (Cont'd)

C. Discount rate (WACC)

1) Cost of debt capital
$r_D = r_F$ + default risk premium

2) Cost of equity
$r_E = r_F$ + business risk premium
+ financial risk premium

*Ways to estimate $r_E$*

a) CAPM
b) dividend growth model
c) P/E ratios

3) Calculate weighted average cost of debt and equity

D. Calculate discounted value of unlevered free cash flows and terminal value using WACC.

- Implies total value of company
- Deduct debt to find value created for acquirer
- Reveals maximum buyer is willing to pay
- Sale at lower price splits gains between buyer and existing owners

E. Sensitivity analysis

- Establishes negotiating range

## DCF REVIEW (cont'd)

## II. DIVIDEND DISCOUNT MODEL (Flows to Equity)

*Necessary Ingredients*

A. Projected dividends (flows to equity)

Free cash flows
- $(1-T_C)$ Interest payments
- Principal payments

= Flows to equity

B. Terminal value (Equity only)

C. Discount rate

- Need target's cost of equity capital
  $r_E = r_F$ + business risk premium
  + financial risk premium

Correct for planned changes in capital structure

D. Calculate discounted value of flows to equity and terminal value using cost of equity capital.

- Directly implies equity value of target company, and intrinsic value to acquirer

E. Sensitivity analysis

## DCF REVIEW (cont'd)

### III. ADJUSTED PRESENT VALUE

*Necessary Steps*

A. Use unlevered free cash flows and total terminal value as defined before

B. Discount these amounts using *asset* required return:

$$r_A = r_F + \text{business risk premium},$$

required return if target is *all-equity*

C. Implies unlevered value of the firm

D. Adjust unlevered value for present value of incremental benefits of acquisition and financing package

1) Present value of interest tax shields at pre-tax cost of borrowing

2) Subsidized debt

3) Tax savings from writing-up of assets to fair value

E. Sensitivity analysis

# ALTERNATIVE VALUATION METHODS

In addition to Discounted Cash Flow (DCF) approach, several popular valuation techniques:

- Price/earnings (P/E) ratio
- Market/book value ratio
- Breakup value
- Liquidation value

Methods used to provide:

- Estimates of terminal value for DCF calculation
- Simpler alternative to DCF calculation
- External (market) check on DCF result

Key question: When are alternatives good? and when are they misleading?

## ALTERNATIVE VALUATION METHODS (cont'd)

### I. Price/earnings (P/E) ratio

Price/earnings ratio is calculated as:

$$\frac{P}{E} = \frac{\text{price share}}{\text{earnings per share'}}$$

where earnings are either:

- estimate of next year
- immediate past year

Equivalently, $\frac{P}{E}$ can be calculated as:

$$\frac{P}{E} = \frac{\text{market value of outstanding shares}}{\text{total flows to equity}}$$

*Uses*

A. Benchmark for determining theoretical value

Intrinsic value: P/E x Earnings
Potential target if P/E < industry average
Widely used 'back-of-envelope' method

B. Criterion for acquisition target

*Is target P/E below average?*
If so, appears to be 'undervalued', good target

## P/E PITFALLS

P/E ratios will differ across firms for a number of reasons:

- Growth

  Plowback rates
  Returns on reinvested funds

- Business risk

  Firms with different $r_A$'s will have different P/Es

- Financial risk

  Firms with different leverage will have different P/Es even if same $r_A$'s

- Accounting idiosyncracies

  E.g., depreciation rules, age of plant => different accounting earnings for <=> economic earnings

- Assets with no corresponding impact on earnings

  Excess cash valuable, but not reflected in earnings
  Real estate may have value not apparent in income statement

*Be careful in using P/E to conclude firm is undervalued, or to estimate intrinsic value of target*

# VARIATION IN P/E RATIOS

(From Foster, Financial Statement Analysis, 2nd Edition, p. 440, Prentice-Hall, 1986)

## *Over time:*

TABLE 12.1 PE Ratios of Compustat Firms: Time-Series and Cross-Sectional Differences

*Panel A: Time-Series Data for 1964–1983*

| *Year* | *.1 Decile* | *.3 Decile* | *.5 Decile* | *.7 Decile* | *.9 Decile* | *No. of Firms* |
|---|---|---|---|---|---|---|
| 1964 | 8.2 | 11.6 | 14.8 | 18.3 | 24.9 | 1.227 |
| 1965 | 9.2 | 12.4 | 15.0 | 18.2 | 27.5 | 1.273 |
| 1966 | 6.6 | 9.1 | 11.6 | 14.8 | 22.7 | 1.357 |
| 1967 | 9.7 | 12.6 | 15.5 | 22.0 | 40.8 | 1,414 |
| 1968 | 12.4 | 15.6 | 19.5 | 26.8 | 51.2 | 1.537 |
| 1969 | 8.5 | 11.2 | 14.2 | 20.2 | 37.6 | 1.639 |
| 1970 | 6.5 | 11.2 | 13.8 | 18.6 | 31.2 | 1.710 |
| 1971 | 7.7 | 11.5 | 14.8 | 20.5 | 37.2 | 1.822 |
| 1972 | 7.8 | 10.5 | 13.2 | 18.2 | 35.1 | 1,930 |
| 1973 | 3.6 | 5.5 | 7.5 | 10.2 | 21.5 | 1,991 |
| 1974 | 1.6 | 3.6 | 4.9 | 6.5 | 12.5 | 2.035 |
| 1975 | 1.5 | 5.2 | 6.9 | 9.1 | 16.2 | 2.054 |
| 1976 | 3.7 | 6.4 | 8.0 | 9.8 | 15.5 | 2,087 |
| 1977 | 3.8 | 6.1 | 7.4 | 9.1 | 13.8 | 2.121 |
| 1978 | 3.8 | 5.5 | 6.8 | 8.4 | 13.5 | 2.163 |
| 1979 | 3.7 | 5.5 | 6.8 | 9.2 | 15.9 | 2.196 |
| 1980 | 4.0 | 6.1 | 7.8 | 11.5 | 22.5 | 2,242 |
| 1981 | 3.0 | 5.9 | 7.4 | 10.2 | 19.3 | 2,307 |
| 1982 | −3.8 | 6.6 | 9.5 | 13.3 | 27.0 | 2,323 |
| 1983 | −4.0 | 7.7 | 10.8 | 14.5 | 27.2 | 2.140 |

## *Across industries at particular points in time:*

*Panel B: Cross-Sectional Data for 1983*

| *SIC Code* | *Short Industry Title* | *Deciles of Distribution* .1 | .3 | .5 | .7 | .9 | *No. of Observations* |
|---|---|---|---|---|---|---|---|
| 1311 | Oil, crude producers | −13.18 | .30 | 12.50 | 17.14 | 32.16 | 67 |
| 2300 | Textile apparel manufacturing | −2.90 | 8.27 | 9.22 | 11.12 | 20.50 | 37 |
| 2600 | Paper and allied products | −28.50 | 11.22 | 14.38 | 18.37 | 27.34 | 24 |
| 2830 | Drugs | 8.92 | 11.45 | 12.92 | 15.48 | 32.77 | 28 |
| 2911 | Petroleum refining | −2.29 | 7.41 | 8.67 | 12.53 | 17.99 | 41 |
| 3310 | Steel and blast furnaces | −41.38 | −7.16 | −3.49 | 2.81 | 28.92 | 29 |
| 3560 | General industrial machinery | −30.34 | −4.53 | 12.59 | 20.54 | 131.73 | 26 |
| 3662 | Radio and T.V. transmitting equipment | −15.42 | 13.68 | 17.31 | 21.70 | 49.92 | 34 |
| 3679 | Electronic components | −3.29 | 12.96 | 22.27 | 27.11 | 35.23 | 22 |
| 4511 | Air transport | −16.98 | −3.57 | −.88 | 8.16 | 18.71 | 22 |
| 4924 | Natural gas | 6.13 | 6.99 | 7.38 | 8.23 | 11.13 | 42 |
| 4931 | Electric and other services | 4.73 | 5.97 | 6.58 | 7.24 | 8.10 | 48 |
| 5411 | Retail food chains | 7.45 | 9.56 | 10.27 | 12.62 | 19.09 | 30 |
| 6312 | Life insurance | 6.64 | 7.67 | 8.32 | 8.69 | 11.52 | 26 |
| 6798 | Real estate investment trusts | −6.87 | 8.99 | 10.80 | 12.11 | 18.36 | 44 |

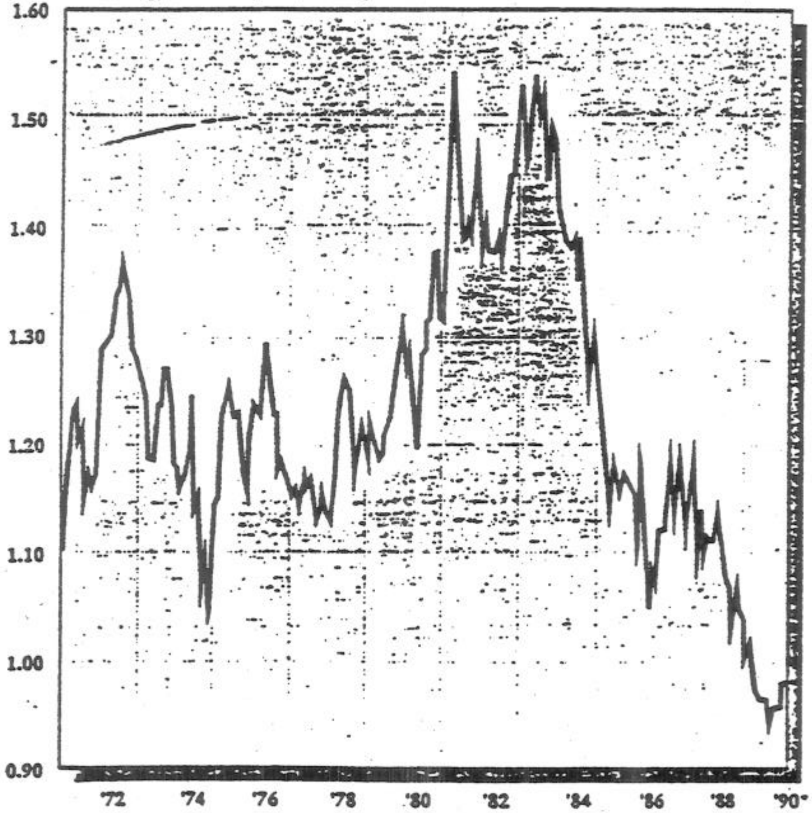
SOURCE: Computed from 1983 Compustat annual industrial file.

# VARIATION IN P/E RATIOS (CONT'D)

## Technology is not what it used to be

Though technology has had some hot months lately, the group still trades cheaper in relation to the overall market than it has in 20 years. The chart compares the price/earnings ratio of technology stocks with the price/earnings ratio of the S&P 500. If the late-1980s takeover era is drawing to an end, perhaps the day of growth stocks is again at hand.

Technology's relative price/earnings ratio



* Through Apr. 30.

*Source: Morgan Stanley Co*

# ALTERNATIVE VALUATION METHODS (cont'd)

## II. Market/book value ratio

Market/book ratio calculated as:

$$\frac{M}{B} = \frac{\text{market value of shares outstanding}}{\text{book value of equity}},$$

Book value of equity <=> net worth of firm

*Uses*

A. Benchmark for determining theoretical value

Intrinsic value: M/B x Net worth

Widely used 'back-of-envelope' method

B. Criterion for acquisition target

*Is target M/B below average?*

If so, appears to be 'undervalued', good target

# UNDERSTANDING MARKET/BOOK VARIATION

Insights from accounting identities:

$$\frac{M}{B} = \frac{\text{market value of shares outstanding}}{\text{book value of equity}}$$

$$= \frac{P \times \#\ \text{shares}}{\text{net worth}}$$

$$= \frac{P \times \#\ \text{shares}}{\text{net income}} \times \frac{\text{net income}}{\text{net worth}}$$

$$= \frac{P}{E} \times \text{ROE}$$

$$= \frac{P}{E} \times \frac{\text{net income}}{\text{sales}} \times \frac{\text{sales}}{\text{assets}} \times \frac{\text{assets}}{\text{net worth}}$$

## M/B PITFALLS

M/B ratios will differ across firms for a number of reasons:

- Above reasons for variation in P/E
- Profit margin

  Different emphasis in product lines
  Differences in regional concentrations
- Capital intensity

  Accounting idiosyncracies
- Financial leverage

  Less equity may support higher sales

*Be careful in using M/B to conclude firm is undervalued, or to estimate intrinsic value of target*

# VARIATION IN MARKET/BOOK RATIOS

(From Foster, Financial Statement Analysis, 2nd Edition, p. 452, Prentice Hall, 1986)

*Over time:*

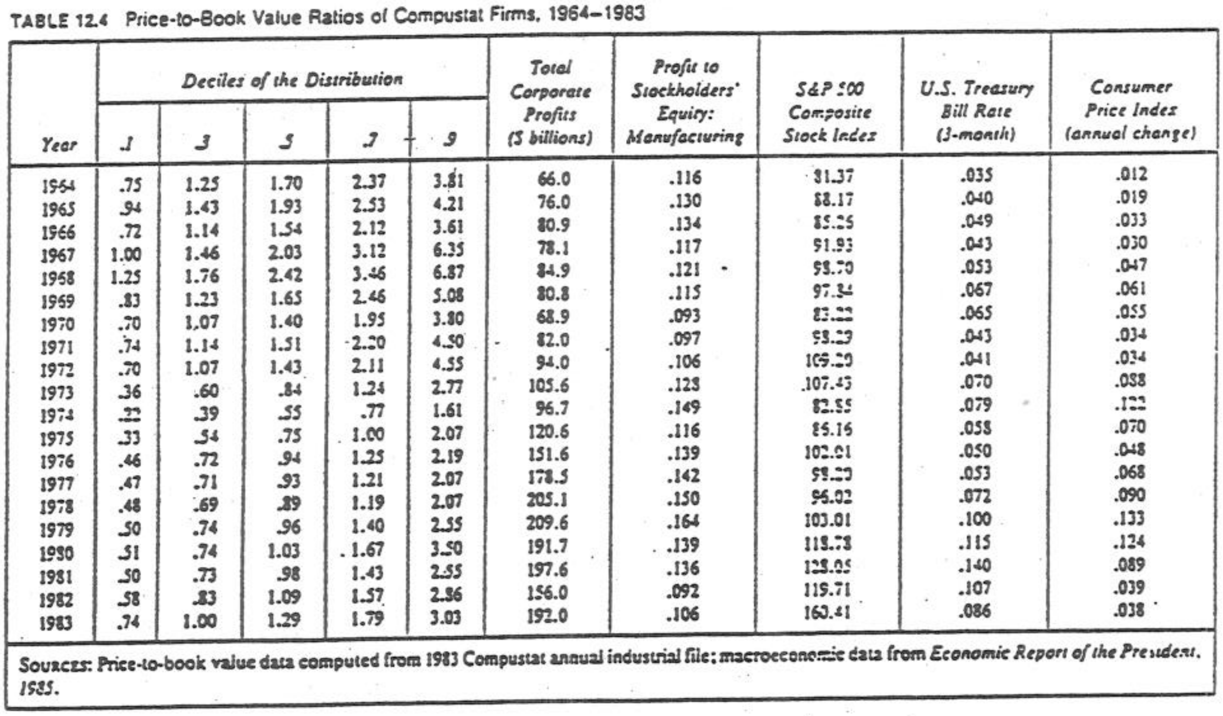


TABLE 12.4 Price-to-Book Value Ratios of Compustat Firms, 1964–1983

| *Year* | *Deciles of the Distribution* | | | | | *Total Corporate Profits ($ billions)* | *Profit to Stockholders' Equity: Manufacturing* | *S&P 500 Composite Stock Index* | *U.S. Treasury Bill Rate (3-month)* | *Consumer Price Index (annual change)* |
|---|---|---|---|---|---|---|---|---|---|---|
| | *.1* | *.3* | *.5* | *.7* | *.9* | | | | | |
| 1964 | .75 | 1.25 | 1.70 | 2.37 | 3.81 | 66.0 | .116 | 81.37 | .035 | .012 |
| 1965 | .94 | 1.43 | 1.93 | 2.53 | 4.21 | 76.0 | .130 | 88.17 | .040 | .019 |
| 1966 | .72 | 1.14 | 1.54 | 2.12 | 3.61 | 80.9 | .134 | 85.26 | .049 | .033 |
| 1967 | 1.00 | 1.46 | 2.03 | 3.12 | 6.35 | 78.1 | .117 | 91.93 | .043 | .030 |
| 1968 | 1.25 | 1.76 | 2.42 | 3.46 | 6.87 | 84.9 | .121 | 98.70 | .053 | .047 |
| 1969 | .83 | 1.23 | 1.65 | 2.46 | 5.08 | 80.8 | .115 | 97.84 | .067 | .061 |
| 1970 | .70 | 1.07 | 1.40 | 1.95 | 3.80 | 68.9 | .093 | 83.22 | .065 | .055 |
| 1971 | .74 | 1.14 | 1.51 | 2.20 | 4.50 | 82.0 | .097 | 98.29 | .043 | .034 |
| 1972 | .70 | 1.07 | 1.43 | 2.11 | 4.55 | 94.0 | .106 | 109.20 | .041 | .034 |
| 1973 | .36 | .60 | .84 | 1.24 | 2.77 | 105.6 | .123 | 107.43 | .070 | .088 |
| 1974 | .22 | .39 | .55 | .77 | 1.61 | 96.7 | .149 | 82.85 | .079 | .122 |
| 1975 | .33 | .54 | .75 | 1.00 | 2.07 | 120.6 | .116 | 86.16 | .058 | .070 |
| 1976 | .46 | .72 | .94 | 1.25 | 2.19 | 151.6 | .139 | 102.01 | .050 | .048 |
| 1977 | .47 | .71 | .93 | 1.21 | 2.07 | 178.5 | .142 | 98.20 | .053 | .068 |
| 1978 | .48 | .69 | .89 | 1.19 | 2.07 | 205.1 | .150 | 96.02 | .072 | .090 |
| 1979 | .50 | .74 | .96 | 1.40 | 2.55 | 209.6 | .164 | 103.01 | .100 | .133 |
| 1980 | .51 | .74 | 1.03 | 1.67 | 3.50 | 191.7 | .139 | 118.78 | .115 | .124 |
| 1981 | .50 | .73 | .98 | 1.43 | 2.55 | 197.6 | .136 | 128.05 | .140 | .089 |
| 1982 | .58 | .83 | 1.09 | 1.57 | 2.86 | 156.0 | .092 | 119.71 | .107 | .039 |
| 1983 | .74 | 1.00 | 1.29 | 1.79 | 3.03 | 192.0 | .106 | 160.41 | .086 | .038 |

SOURCES: Price-to-book value data computed from 1983 Compustat annual industrial file; macroeconomic data from *Economic Report of the President, 1985.*

# ALTERNATIVE VALUATION METHODS (cont'd)

## III. Breakup value

*Issue* : Would the firm be worth more if broken up into its separate components?

Try to make this judgment based on:

- DCF (and sensitivity) analysis
- market prices of comparable firms/transactions

Conditions that may lead to value to split up:

- Diseconomies of scale/scope

  More efficient to operate firm at lower output level or with fewer products

- Piece of firm may be more valuable to different owner

  Other firm may have economies to reap

- Average multiple effect

  Analysts unable to value firm with too many activities - consolidated financial statements

- Strategic issues

  Concentrate on 'core business'

## ALTERNATIVE VALUATION METHODS (cont'd)

### IV. Liquidation value

*Issue* : Would the firm be worth more if assets are sold?

Conditions that suggest firm is worth more 'dead' than 'alive':

- Insignificant intangible assets

  No special reputation in industry

- Low R&D promise

  Patents, if present, are salable

- Valuable personnel have alternative opportunities

### Costs of Liquidation

- Efficiency of secondary market for assets
- Tax liability for excess of sale price over book

# SUMMARY OF VALUATION APPROACHES

## *DCF Techniques*

Most general approach, allowing for any cash flow timing or risk

But valuation only as good as cash flow projections

Useful to check answers against market value

## *P/E and M/B Ratios*

Easy to apply and understand

But inter-firm accounting and economic differences can cause significant variation in these measures

## *Breakup Value*

Important check on optimal firm size - empire building by management

But still requires a valuation method to determine if assets are worth more to another company

## *Liquidation Value*

Important check on viability of 'going concern'

But rare to resort to liquidation

WHARTON REPROGRAPHICS

# THE CAPITAL ASSET PRICING MODEL

chap. 9, 10, 12

# INTRODUCTION TO RETURN AND RISK

Definition of return:

$$\frac{\begin{matrix}\text{Ending price} \\ \text{of a share}\end{matrix} - \begin{matrix}\text{Beginning} \\ \text{price}\end{matrix} + \begin{matrix}\text{Cash} \\ \text{dividend}\end{matrix}}{\text{Beginning price}}$$

$$= \frac{P_1 - P_0 + \text{Div}}{P_0}$$

$$= \frac{\text{Div}}{P_0} + \frac{P_1 - P_0}{P_0}$$

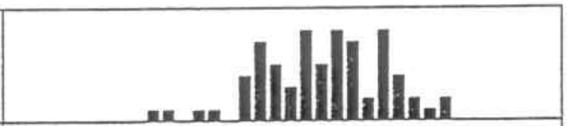
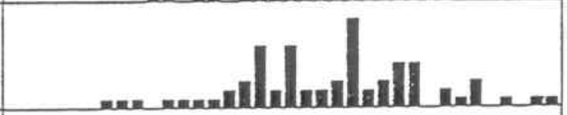
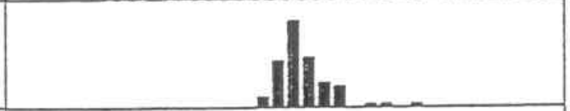
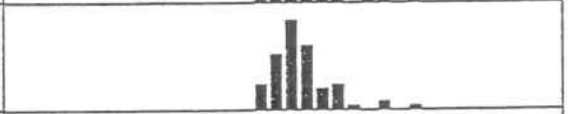
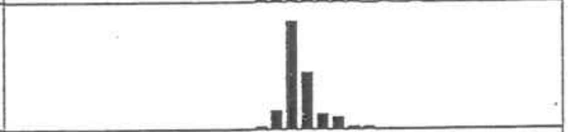
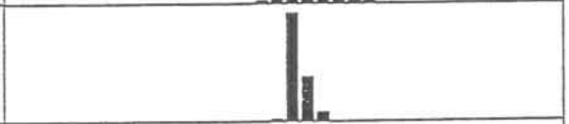
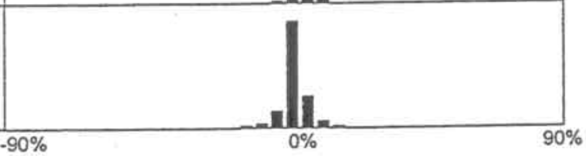
Arithmetic return vs. Geometric return

Arithmetic usually greater than geometric

## Table 2-1

## Basic Series: Summary Statistics of Annual Total Returns

From 1926 to 1995

| Series | Geometric Mean | Arithemetic Mean | Standard Deviation | Distribution |
|---|---|---|---|---|
| **Large Company Stocks** | 10.5% | 12.5% | 20.4% |  |
| **Small Company Stocks** | 12.5 | 17.7 | 34.4 |  * |
| **Long-Term Corporate Bonds** | 5.7 | 6.0 | 8.7 |  |
| **Long-Term Government** | 5.2 | 5.5 | 9.2 |  |
| **Intermediate-Term Government** | 5.3 | 5.4 | 5.8 |  |
| **U.S. Treasury Bills** | 3.7 | 3.8 | 3.3 |  |
| **Inflation** | 3.1 | 3.2 | 4.6 |  |
| | | | | -90% 0% 90% |

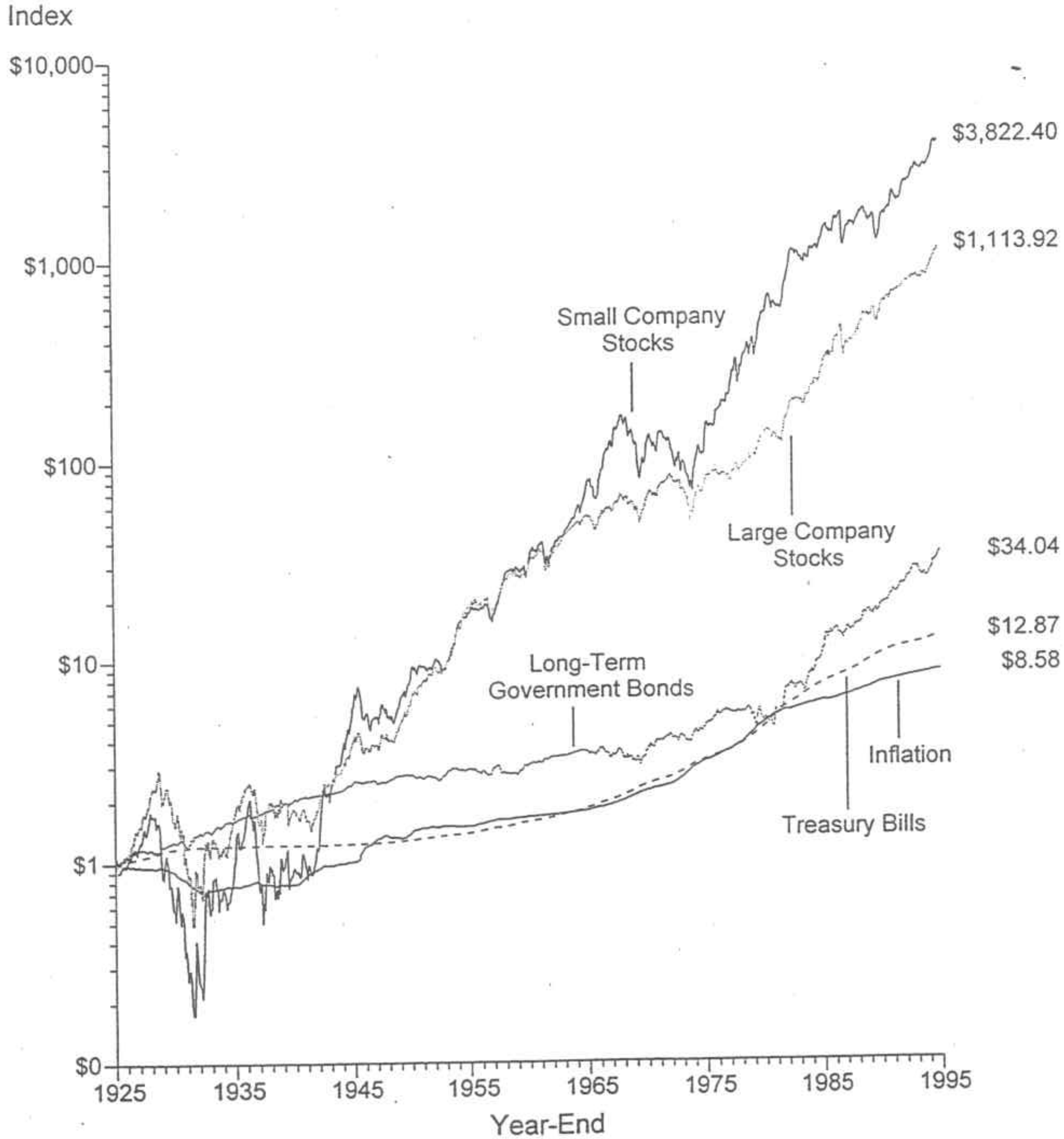
*The 1933 Small Company Stock Total Return was 142.9 percent.

**Graph 2-1**

**Wealth Indices of Investments in the U.S. Capital Markets**

Year-End 1925 = $1.00

**From 1925 to 1995**



# AVERAGE ANNUAL RETURNS

# RISK OF A SINGLE SECURITY (STANDARD DEVIATION)

| Year | Return | Deviation from Average | Squared Deviation |
|---|---|---|---|
| 1 | 58.9 | 46.67 | 2178.09 |
| 2 | 26.1 | 13.87 | 192.38 |
| 3 | −39.4 | −51.63 | 2665.66 |
| 4 | −38.1 | −50.33 | 2533.11 |
| 5 | 38.3 | 26.07 | 679.64 |
| 6 | 26.1 | 13.87 | 192.38 |
| 7 | 13.7 | 1.47 | 2.16 |
| Sum | 85.6 | −0.01 | 8443.41 |
| Average | 12.23 | | 1407.24 |
| Square Root | | | 37.51 |

What changes if the returns are the possible future outcomes, each with a probability of 1/7?

# FORMULAE

Using past data:

$$\frac{\sum_{t=1}^{T}\left(R_t - \bar{R}\right)^2}{T-1}$$

Using forecasted distribution:

$$\frac{\sum_{t=1}^{T}\left(R_t - E(R)\right)^2}{T}$$

# TWO USEFUL PROPERTIES

1. $\sigma^2\Big(\sum_{t=1}^{T} R_t\Big)$

   $= \sigma_1^2 + \sigma_2^2 + \cdots + \sigma_T^2$ , assuming independence

   $= T \cdot \sigma^2$ , if all variances are the same

$$\sigma\Big(\sum_{t=1}^{T} R_t\Big) = \sqrt{T} \cdot \sigma$$

2. $$\begin{aligned} \sigma^2(A \cdot R_i) &= A^2 \cdot \sigma^2(R_i) \\ \sigma(A \cdot R_i) &= A \cdot \sigma(R_i) \end{aligned}$$

# ESTIMATING AVERAGE AND STANDARD DEVIATION

$$\bar{R} = \sum_{t=1}^{T} \frac{R_t}{T}$$

$$\sigma^2(R) = \sigma^2 = \sum_{t=1}^{T} \frac{(R_t - \bar{R})^2}{T-1}$$

$$\begin{aligned}
\sigma^2(\bar{R}) &= \sigma^2\left(\sum_{t=1}^{T} \frac{R_t}{T}\right) \\
&= \frac{1}{T^2}\,\sigma^2\left(\sum_{t=1}^{T} R_t\right) && \text{(Rule 2)} \\
&= \frac{1}{T^2}\left[\sigma^2(R_1) + \sigma^2(R_2) + \cdots + \sigma^2(R_T)\right] && \text{(Rule 1)} \\
&= \frac{1}{T^2} \cdot T \cdot \sigma^2 \\
&= \frac{\sigma^2}{T}
\end{aligned}$$

$$\sigma(\bar{R}) = \frac{1}{\sqrt{T}} \cdot \sigma$$

*t*-statistic: $\dfrac{\bar{R} - K}{\text{std. error}} = \dfrac{\bar{R} - K}{\sigma/\sqrt{T}} = \dfrac{\bar{R} - K}{\sigma}\sqrt{T}$

$$R_{\mathsf{YEAR}} \cong R_{\mathsf{JAN}} + R_{\mathsf{FEB}} + \cdots + R_{\mathsf{DEC}}$$

$$\sigma^2(R_{\mathsf{YEAR}}) \cong \sigma^2(R_{\mathsf{JAN}} + R_{\mathsf{FEB}} + \cdots + R_{\mathsf{DEC}})$$

$$\sigma^2_{\mathsf{YEAR}} \cong \sigma^2_{\mathsf{JAN}} + \sigma^2_{\mathsf{FEB}} + \cdots + \sigma^2_{\mathsf{DEC}} \qquad \text{(Rule 1)}$$

$$\sigma^2_{\mathsf{YEAR}} \cong 12 \cdot \sigma^2_{\mathsf{MONTHLY}}$$

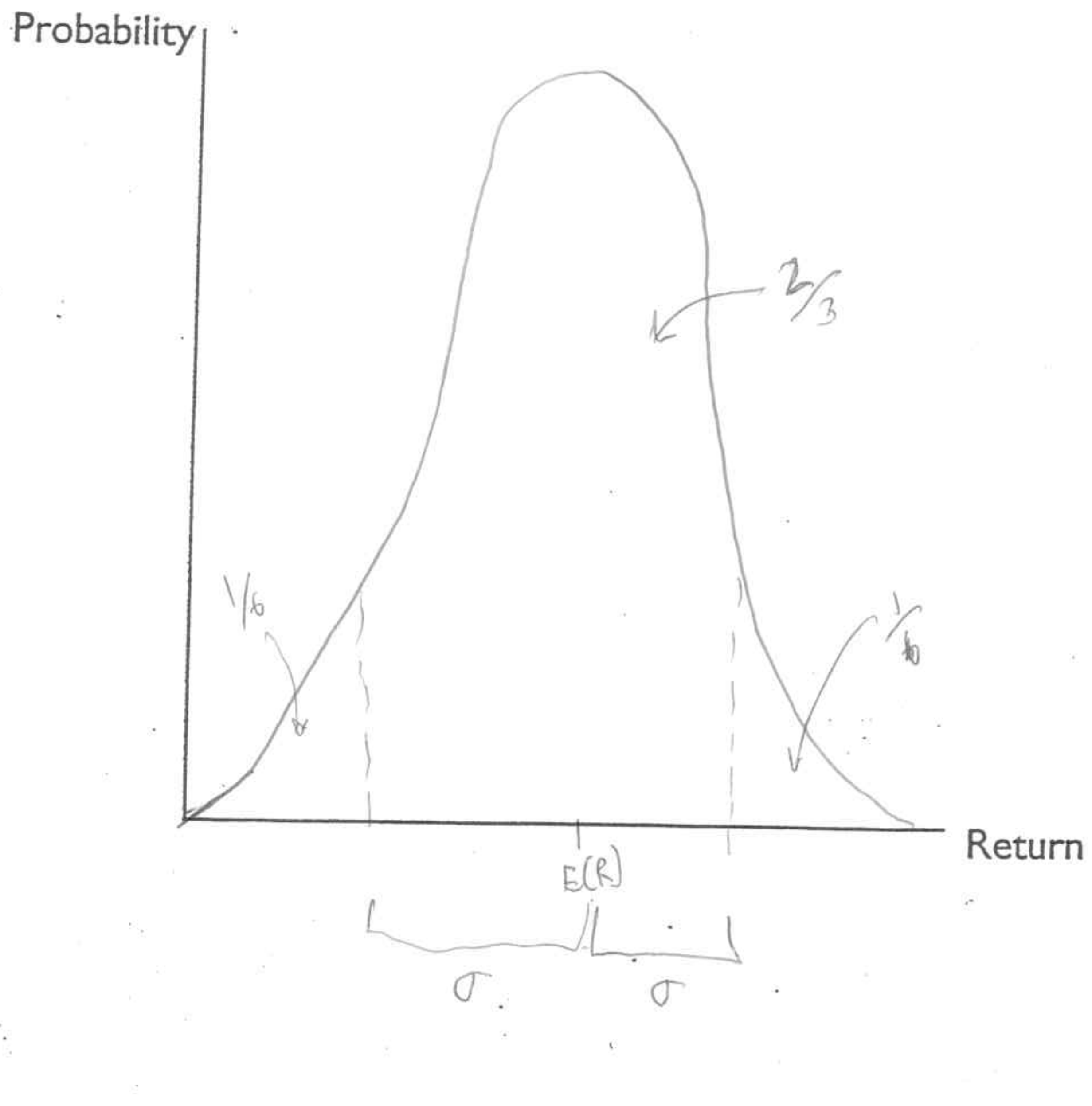
$$\sigma_{\mathsf{YEAR}} \cong \sqrt{12} \cdot \sigma_{\mathsf{MONTHLY}}$$

$$R_{\text{AVE. MONTHLY}} = \frac{R_{\text{JAN}} + R_{\text{FEB}} + \cdots + R_{\text{DEC}}}{12}$$

$$\begin{aligned}
&\sigma^2(R_{\text{AVE. MONTHLY}}) \\
&= \left(\frac{1}{12}\right)^2 \sigma^2(R_{\text{JAN}} + R_{\text{FEB}} + \cdots + R_{\text{DEC}}) \\
&\qquad\qquad\qquad\qquad\qquad\qquad \text{(Rule 2)} \\
&= \left(\frac{1}{12}\right)^2 \cdot 12 \cdot \sigma^2_{\text{MONTHLY}} \qquad \text{(Rule 1)} \\
&= \frac{1}{12} \cdot \sigma^2_{\text{MONTHLY}}
\end{aligned}$$

$$\sigma(R_{\text{AVE. MONTHLY}}) = \frac{1}{\sqrt{12}} \cdot \sigma_{\text{MONTHLY}}$$

# The Bell-Shaped Curve



# Real World Standard Deviations

- Standard deviation for market as whole
- Standard deviation for individual securities
- Relationship between standard deviations over different periods

Greater over a year than over a month.

# CORRELATION

| | Return on $A$ | Return on $B$ | Deviation of $R_A$ | Deviation of $R_B$ | Product of Deviations |
|---|---|---|---|---|---|
| Boom | 0.12 | 0.23 | 0.04 | 0.14 | 0.0056 |
| Normal | 0.08 | 0.15 | 0 | 0.06 | 0 |
| Bust | 0.04 | −0.11 | −0.04 | −0.20 | 0.008 |
| | | | | | 0.0136 |
| Average | 0.08 | 0.09 | | | |
| Std. Dev. $\sigma$ | 0.033 | 0.145 | | | |

covariance = average
= 0.0136/3 = .0045

$$\rho = \text{correlation} = \frac{\text{covariance}}{\text{std. dev. of } A \times \text{std. dev. of } B}$$

$$= \frac{.0045}{.033 \times .145} = .947$$

What changes if the returns are past observations?

# RULES OF COVARIANCES

1. $\mathrm{cov}(A, B{+}C) = \mathrm{cov}(A, B) + \mathrm{cov}(A, C)$
2. $\mathrm{cov}(A, K{\cdot}B) = K\,\mathrm{cov}(A, B)$
3. $\mathrm{cov}(A, A) = \sigma_A^2$

Example:

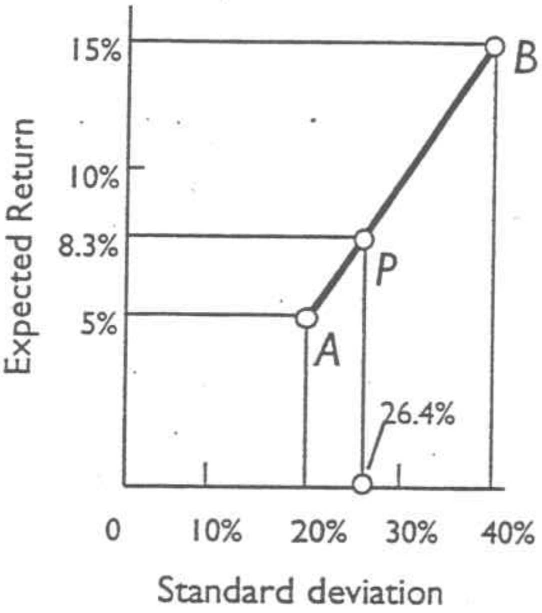
$$R_P = \sum_{i=1}^{N} X_i\,R_i = X_1\,R_1 + X_2\,R_2 + \cdots + X_N\,R_N$$

$$\begin{aligned}
\mathrm{cov}(R_A, R_P) &= \mathrm{cov}\Big(R_A, \sum_{i=1}^{N} X_i\,R_i\Big) \\
&= \mathrm{cov}(R_A, X_1\,R_1) + \mathrm{cov}(R_A, X_2\,R_2) + \cdots \\
&\quad + \mathrm{cov}(R_A, X_N\,R_N) \qquad \text{(Rule 1)} \\
&= X_1\,\mathrm{cov}(R_A, R_1) + X_2\,\mathrm{cov}(R_A, R_2) + \cdots \\
&\quad + X_N\,\mathrm{cov}(R_a, R_N) \qquad \text{(Rule 2)} \\
&= \sum_{i=1}^{N} X_i\,\mathrm{cov}(R_A, R_i)
\end{aligned}$$

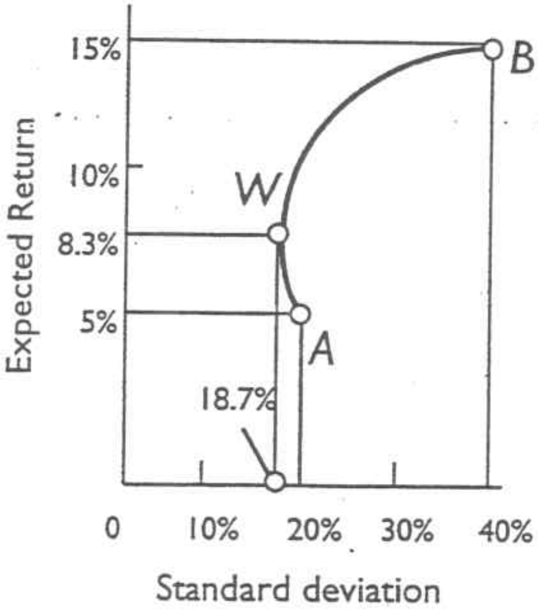
# The Concept of Efficiency

# The Concept of Efficiency

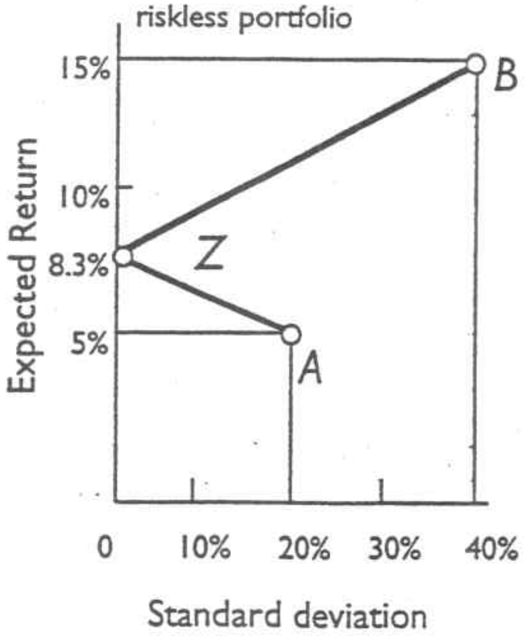
Two perfectly positively correlated assets generate linear portfolio investment opportunities



Two zero correlated assets generate a curve of portfolio possibilities



Two perfectly negatively correlated assets can create a riskless portfolio



# PORTFOLIO OF TWO RISKY ASSETS—

|  | Asset $A$ | Asset $B$ |
|---|---|---|
| $\bar{R}$ | 0.12 | 0.17 |
| $\sigma$ | 0.20 | 0.25 |
| $x$ | 0.35 | 0.65 |

$$\rho = 0.2$$

$$\left[\Rightarrow \operatorname{cov}(R_A, R_B) = \rho\,\sigma_A\,\sigma_B = 0.01\right]$$

Expected return:

$$\bar{R}_P =$$

Variance:

$$\operatorname{var}(R_P) =$$

$$\Rightarrow \quad \sigma_P =$$

Suppose $\rho = 1$

$$\Rightarrow \quad \operatorname{cov}(R_a, R_b) = \sigma_a \cdot \sigma_b$$

$$\sigma_P^2 = X_A^2\,\sigma_A^2 + X_B^2\,\sigma_B^2 + 2\,X_A\,X_B \cdot \sigma_A \cdot \sigma_B$$

$$=$$

$$\sigma_P =$$

Suppose $\rho = -1$

$$\sigma_P^2 = X_A^2\,\sigma_A^2 + X_B^2\,\sigma_B^2 - 2\,X_A\,X_B\,\sigma_A\,\sigma_B$$

$$=$$

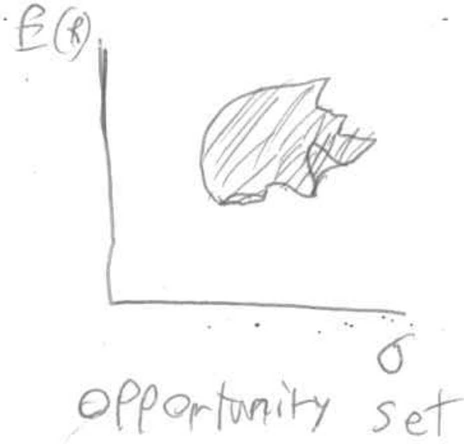
$$\sigma_P =$$

or

$$\sigma_P =$$

Under what conditions does $\sigma_P = 0$?

# The 3 (or more) Asset Case



opportunity set

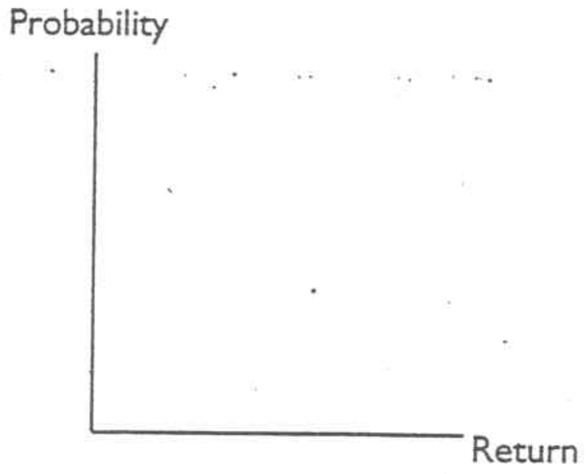
Each point in region represents different portfolio.

Each corner represents an asset (undiversified portfolio).

# The Concept of Diversification

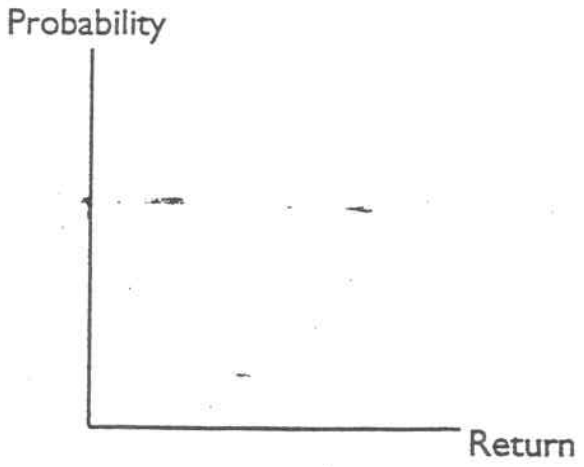
**One Asset**

| State | Return |
|---|---|
| 1 | .20 |
| 2 | -.10 |



**Two Assets**

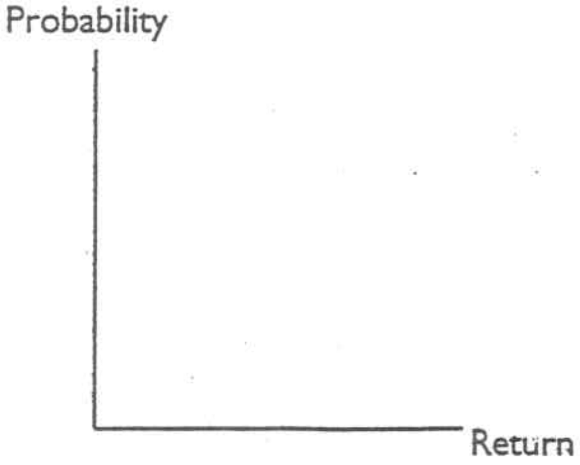
| State | Return$_A$ | Return$_B$ |
|---|---|---|
| 1 | .20 | .20 |
| 2 | .20 | -.10 |
| 3 | -.10 | .20 |
| 4 | -.10 | -.10 |



# The Concept of Diversification (continued)

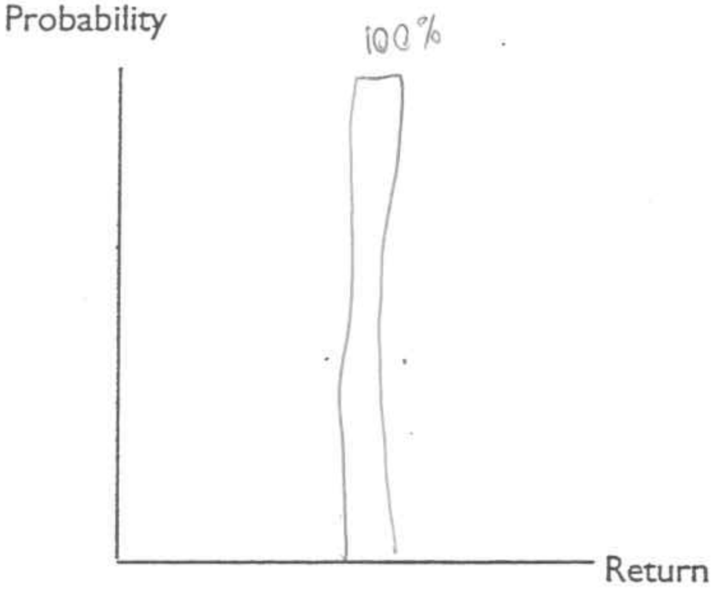
**Three Assets**

| State | Return$_A$ | Return$_B$ | Return$_C$ |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |



# The Concept of Diversification (continued)

N- Assets

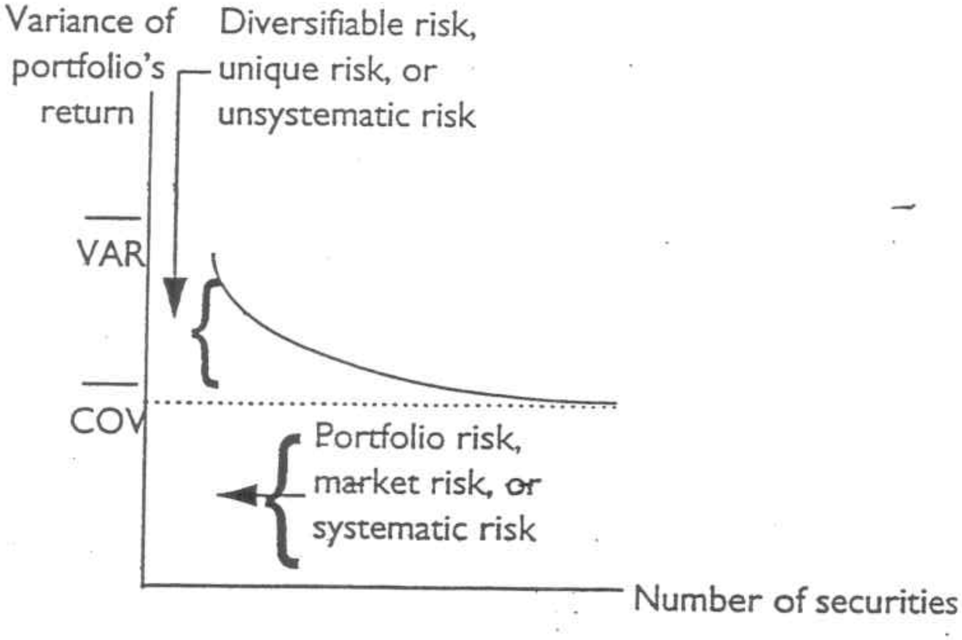


Is this the way the probability distribution for N assets looks in the real world?

Because N can go → ∞ everything averages out to the mean.

# The Concept of Diversification (continued)

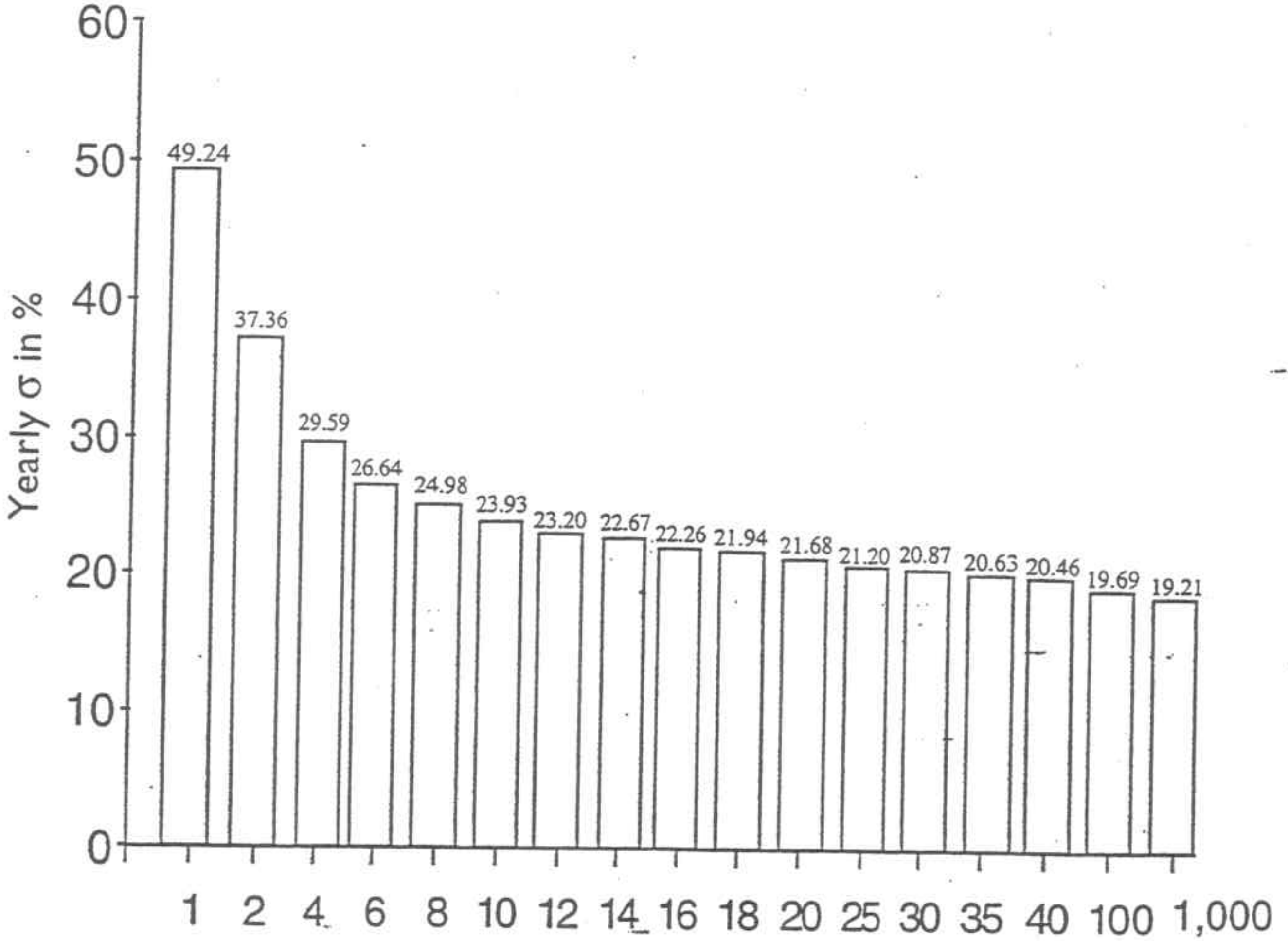
In the real world, security returns are positively correlated. In the example, security returns are independent



- You can not totally diversify risk
- Minimum number of securities to achieve diversification
- Failure to diversify across all asset classes
- Does expected return decline?

# The Concept of Diversification (continued)

In real world, how much can be diversified away?

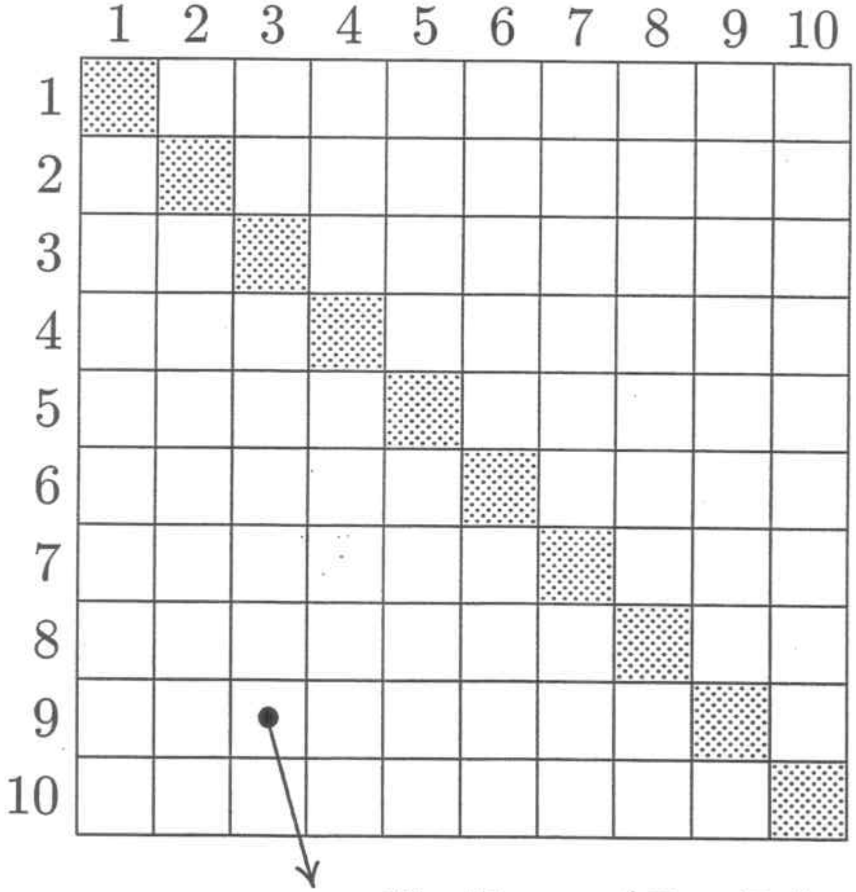


# PORTFOLIO VARIANCE—

Two assets:

| | (1) | (2) |
|---|---|---|
| (1) | $X_1^2\,\sigma_1^2$ | $X_1\,X_2\,\mathrm{cov}(R_1, R_2)$ |
| (2) | $X_1\,X_2\,\mathrm{cov}(R_1, R_2)$ | $X_2^2\,\sigma_2^2$ |

Many assets:



$= X_9\,X_3\,\mathrm{cov}(R_9, R_3)$

# GENERAL FORMULA FOR PORTFOLIO VARIANCE

$$
\begin{array}{ccccccc}
 & & 1 & 2 & 3 & \ldots & \\
 & 1 & X_1^2\,\sigma_1^2 & X_1\,X_2\,\sigma_{12} & X_1\,X_3\,\sigma_{13} & & X_1\,X_N\,\sigma_{1N} \\
 & 2 & X_1\,X_2\,\sigma_{12} & X_2^2\,\sigma_2^2 & & & \\
\text{Stock} & 3 & X_1\,X_3\,\sigma_{13} & & & & \\
 & \vdots & & & & & \\
 & & X_1\,X_N\,\sigma_{1N} & & & & X_N^2\,\sigma_N^2
\end{array}
$$

Key to diversification

| Number of securities in portfolio | Number of covariance terms | Number of variance terms |
|---|---|---|
| 1 | | |
| 2 | | |
| 4 | | |
| 10 | | |
| 100 | | |

# LIMITS TO DIVERSIFICATION

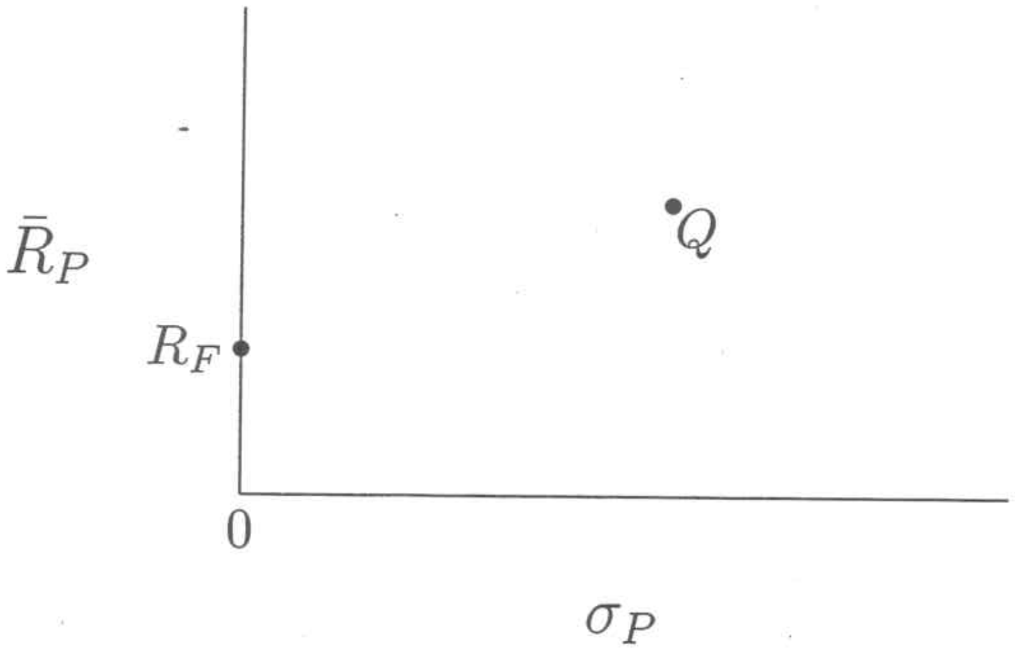
| | |
|---|---|
| Assume all covariances are the same | $\overline{\text{cov}}$ |
| Assume all variances are the same | $\overline{\text{var}}$ |
| Assume all percentage holdings are the same | $\frac{1}{N}$ |

$$\sigma_P^2 =$$

As $N \to \infty$

$$\sigma_P^2 \to$$

# THE CASE OF 1 RISKLESS ASSET AND 1 RISKY ASSET



$$\bar{R}_P = (1-X_Q)R_F + X_Q\,\bar{R}_Q \qquad (1)$$

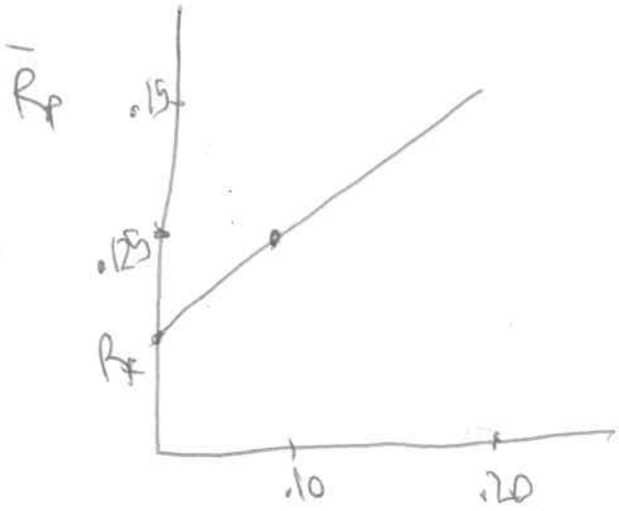
$$\sigma_P^2 = X_F^2\,\sigma_F^2 + X_Q^2\,\sigma_Q^2 + 2\,X_F\,X_Q\,\sigma_{FQ} \qquad (2)$$

What gets eliminated in formula (2)?

Formula (2) simplifies to:

$$\sigma_P^2 = X_Q^2\,\sigma_Q^2$$

$$\sigma_P = X_Q\,\sigma_Q$$



Example:

$$R_F = .10$$

$$\bar{R}_Q = .15$$

$$\sigma_Q = .20$$

If $X_Q = 1/2$

$$\bar{R}_P =$$

$$\sigma_Q =$$

# FINANCIAL LEVERAGE—

Borrow to invest even more in asset $Q$.

Example:

$$r = 0.10\ , \qquad \bar{R}_Q = 0.15$$

$$\text{initial wealth} = \$100$$

Borrow $\$20$ and invest $\$120$ in $Q$

total expected cash = 138

total amount owed = 22

net expected cash = 116

net expected return = .16

Financial leverage expressed as a percentage

$$\bar{R}_P = X \cdot R_F + (1{-}X)\bar{R}_Q$$

# The Risk-Return Trade-Off

# SHORT SELLING (INSTITUTIONAL DETAILS)

# SHORT SELLING EXAMPLE

| Stock | Beginning-of-period price | End-of-period price |
|---|---|---|
| ABC | \$30/share | \$60/share |
| XYZ | \$90/share | \$100/share |

| Stock | Position | Beginning-of-period-value | End-of-period-value |
|---|---|---|---|
| ABC | long 1300 | \$39,000 | \$78,000 |
| XYZ | short 100 | −9,000 | −10,000 |
| | | 30,000 | 68,000 |

$$R_{\text{port}} = \frac{68{,}000 - 30{,}000}{30{,}000} = 126\%$$

$$R_{\text{ABC}} = \frac{60 - 30}{30} = 100\%$$

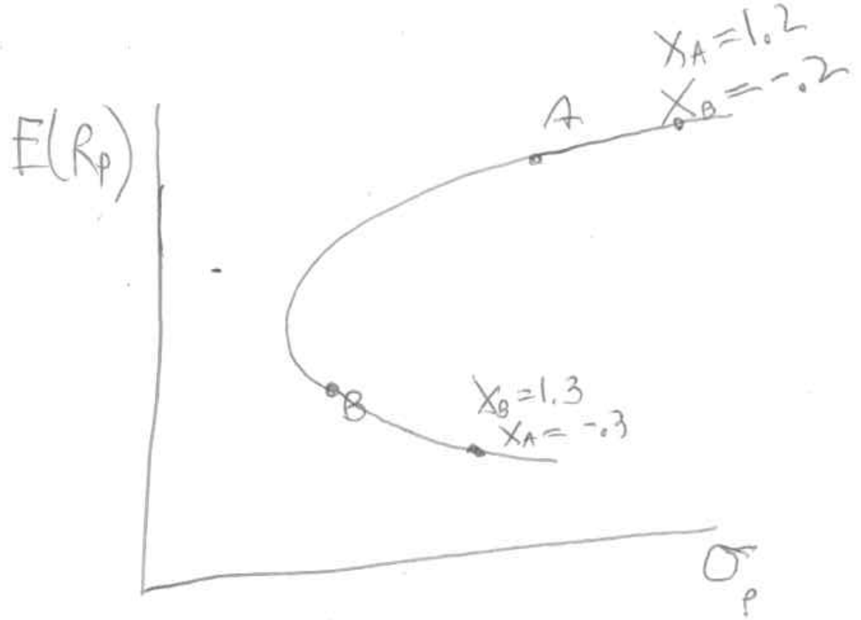
$$R_{\text{XYZ}} = \frac{100 - 90}{90} = 11.1\%$$

$$R_{\text{port}} = X_{ABC} \cdot R_{ABC} + X_{XYZ} \cdot R_{XYZ}$$

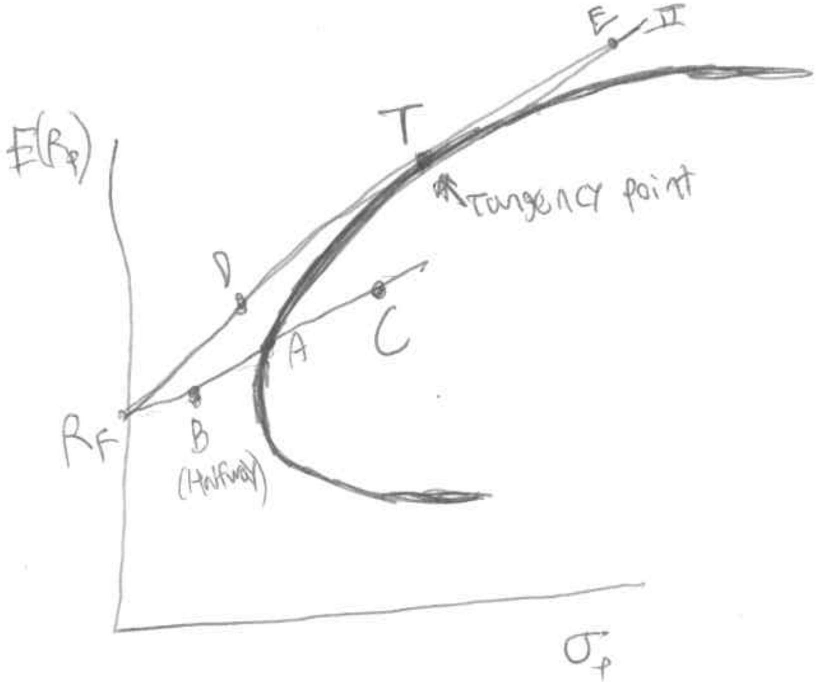
$$(1.3)(1.00) + (-.3) \times (.111)$$

130% of your
money is in ABC
more than 100 b/c
you borrowed

# MANY ASSET CASE WITH SHORT SELLING



# COMBINING RISKLESS ASSET WITH MANY RISKY ASSETS



A

| | |
|---|---|
| AT&T | $20 |
| GM | $45 |
| Xerox | $35 |
| | $100 |

B

| | | |
|---|---|---|
| | AT&T | $10 |
| | GM | $22½ |
| | Xerox | $17½ |
| $50 cash in Bank → | | $50 |
| | | $100 |

C

| | | |
|---|---|---|
| | AT&T | $39 |
| | GM | $67½ |
| | Xerox | $52½ |
| Borrowing $50 (short, etc.) → | | − $50 |
| | | $100 |

Line II is really Good

You can get to D by Lending ~~investing~~ some money in Risk Free rate and some in T

(includes putting money in bank)

You can get to E by investing ~~[illegible]~~ money in T, and borrowing some.

Using your own money

# THE MARKET PORTFOLIO

If everyone has the same expectations, what portfolio of risky assets will they hold?

| Asset | Price | # of Shares | Market Value | Propor-tions | 1% Holdings | 2% Holdings |
|---|---|---|---|---|---|---|
| 1 | $50 | 100 | $5,000 | .328 | $50.00 | $100 |
| 2 | 25 | 10 | 250 | .016 | 2.50 | 5 |
| 3 | 100 | 100 | 10,000 | .656 | 100.00 | 200 |
|  |  |  | $15,250 | 1.000 | $152.50 | $305 |

# SINGLE SECURITY'S CONTRIBUTION TO RISK

$$\sigma_M^2 = \begin{bmatrix} X_1^2\,\sigma_{11} & X_1\,X_2\,\sigma_{12} & X_1\,X_3\,\sigma_{13} & \cdots\cdots\cdots & X_1\,X_N\,\sigma_{1N} \\ X_1\,X_2\,\sigma_{12} & X_2^2\,\sigma_2^2 & X_2\,X_3\,\sigma_{23} & & \\ X_1\,X_3\,\sigma_{13} & X_2\,X_3\,\sigma_{23} & X_3^2\,\sigma_3^2 & & \\ & & & X_4^2\,\sigma_4^2 & \vdots \\ \vdots & & & & \\ & & & \ddots & \\ X_1\,X_N\,\sigma_{1N} & \cdots\cdots\cdots & \cdots\cdots\cdots & \cdots\cdots\cdots & X_N^2\,\sigma_N^2 \end{bmatrix}$$

A single row or column can be written as:

$$X_2[X_1\,\sigma_{12} + X_2\,\sigma_2^2 + X_3\,\sigma_{23} + X_4\,\sigma_{24} + \cdots + X_N\,\sigma_{2N}]$$

This is security 2's contribution to the risk of the portfolio.

$$R_M = \sum_{i=1}^{N} X_i\,R_i$$

$$\sigma_{2M} = \operatorname{cov}(R_2, R_M) = \operatorname{cov}\Big(R_2, \sum_{i=1}^{N} X_i\,R_i\Big) = \sum_{i=1}^{N} X_i\,\sigma_{2i}$$

We can standardize this contribution as:

$$\frac{\sigma_{2M}}{\sigma_M^2} = \beta_2$$

# Beta: The Basics

We previously considered the risk of an individual security by itself. An appropriate measure of risk here is standard deviation.

However, investors generally hold many securities, not one security in isolation. We now want to measure the contribution of a single security to the risk of a large portfolio. Beta is generally considered the best measure of risk here.

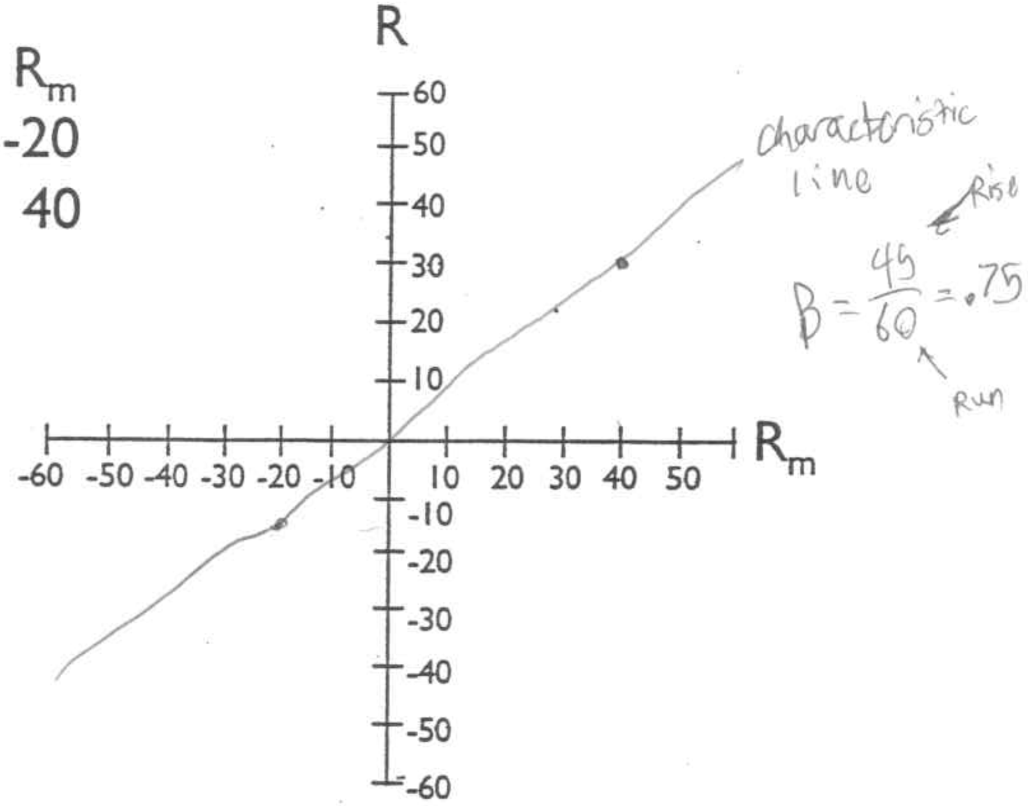
Beta measures the responsiveness of a security to movements in the market

# Beta: The Basics (continued)

## Estimating Beta

a. Fund or stock I

| $R_j$ | $R_m$ |
|---|---|
| -15 | -20 |
| 30 | 40 |



$\beta = \frac{45}{60} = .75$

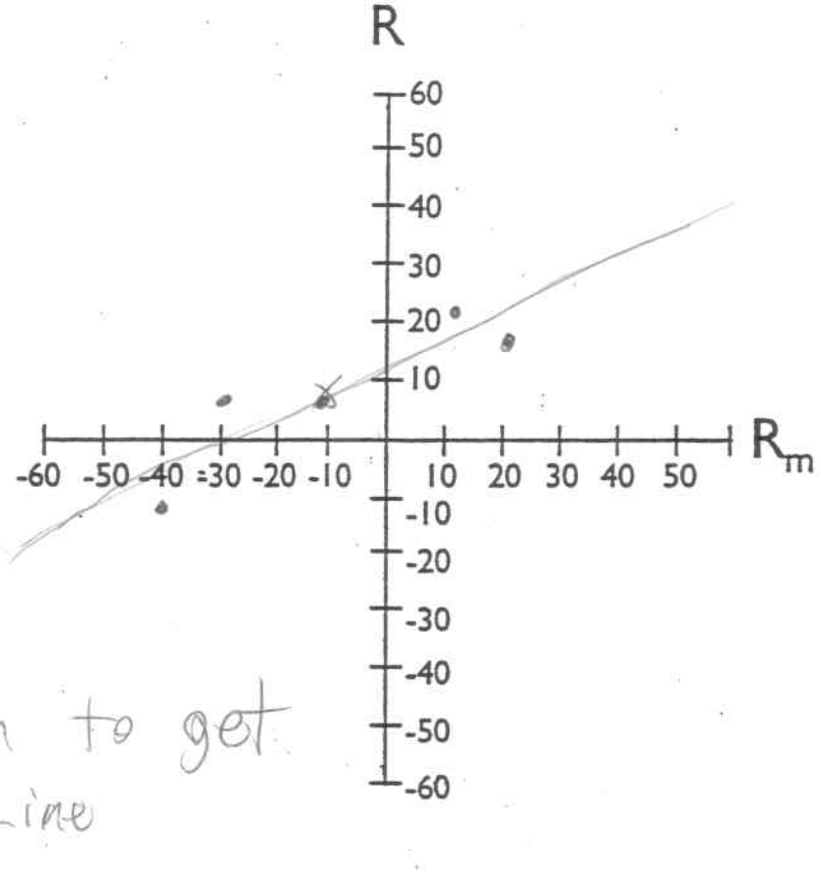
β = slope of characteristic line

measures Responsiveness

# Beta: The Basics (continued)

b. Fund or stock 2

| $R_j$ | $R_m$ |
|---|---|
| .03 | -.30 |
| .15 | .20 |
| .20 | .10 |
| -.10 | -.40 |



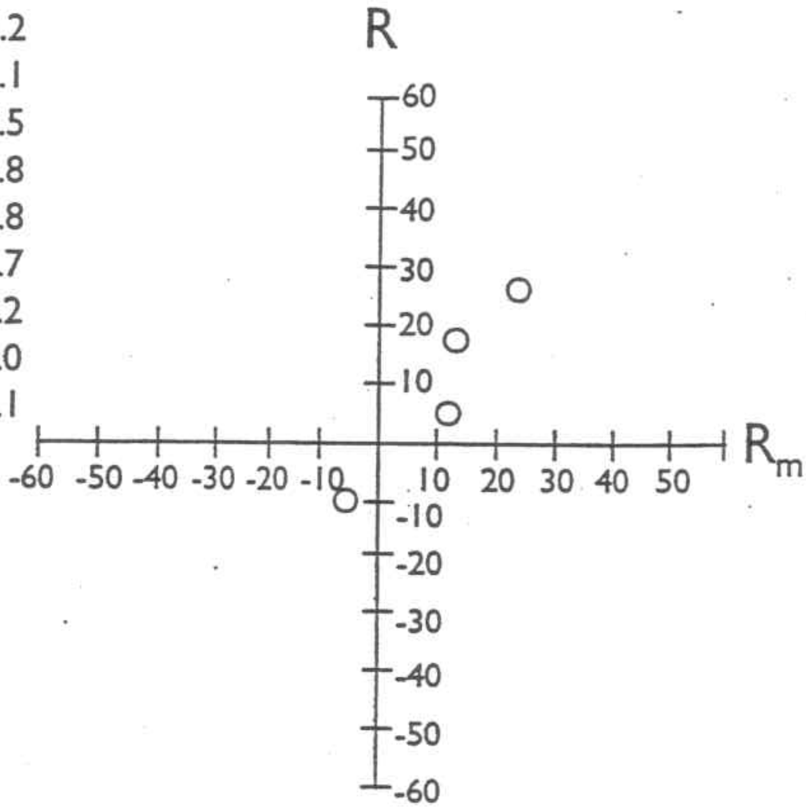
Use Regression to get
Straight Line

# Beta: The Basics (continued)

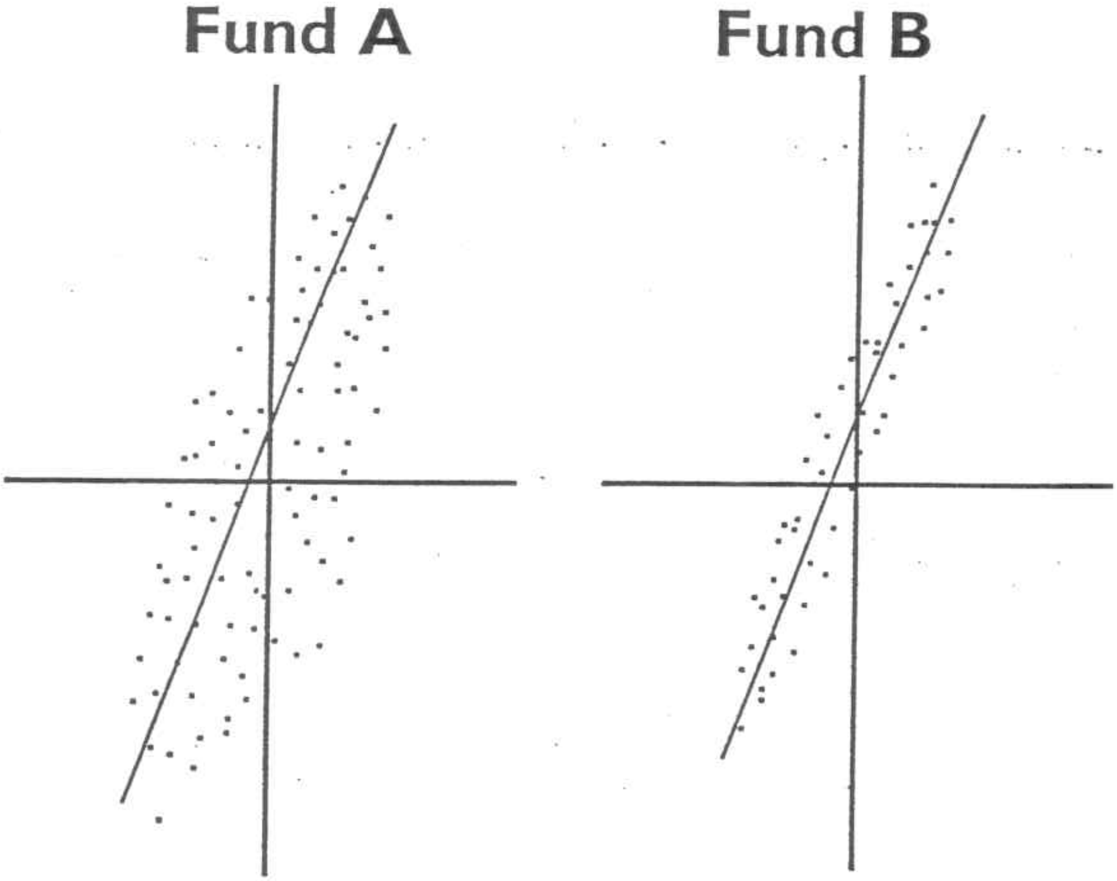
**c. Fund or stock 3**

**Common Stocks (Larger companies)**

| Year | Market | Fund |
|---|---|---|
| 1 | 12.4% | 17.6% |
| 2 | -10.1 | -6.9 |
| 3 | 24.0 | 26.2 |
| 4 | 11.0 | 6.0 |
| 5 | -8.3 | -0.2 |
| 6 | 4.0 | 0.1 |
| 7 | 14.3 | 18.5 |
| 8 | 19.0 | 25.8 |
| 9 | -14.8 | -20.8 |
| 10 | -26.5 | -28.7 |
| 11 | 37.3 | 32.2 |
| 12 | 23.7 | 20.0 |
| 13 | -7.3 | -11.1 |



# Beta vs. Standard Deviation



- $R^2$ - Tightness of Fit
- Independent variation
- Standard deviation

# Beta: The Details

- Typical beta for a stock

| Industry | Beta |
|---|---|
| Electronic components | 1.49 |
| Crude petroleum & natural gas | 1.07 |
| Retail department stores | .95 |
| Petroleum refining | .95 |
| Motor vehicle parts | .89 |
| Chemicals | .88 |
| Metal mining | .87 |
| Food | .84 |
| Trucking | .83 |
| Textile mill products | .82 |
| Paper and allied products | .82 |
| Retail grocery stores | .76 |
| Airlines | .75 |
| Steel | .66 |
| Railroads | .61 |
| Natural gas transmission | .52 |
| Telephone companies | .50 |
| Electric utilities | .46 |

- Factors influencing beta
  - Industry
  - Life cycle of product
  - Leverage

# Beta: The Details (continued)

- Positive, zero and negative betas
- Are betas stable over time?
- How to measure betas in the real world
- Is relationship linear?

# Formula for Beta

$$\beta = \frac{\text{cov}}{\sigma_m{}^2}$$

From before, we know that:

$$\text{cov} = \rho \bullet \sigma \bullet \sigma_m$$

Therefore,

$$\beta = \frac{\rho \bullet \sigma \bullet \sigma_m}{\sigma_m{}^2} = \frac{\rho \bullet \sigma}{\sigma_m}$$

# Example

$\rho = .5$

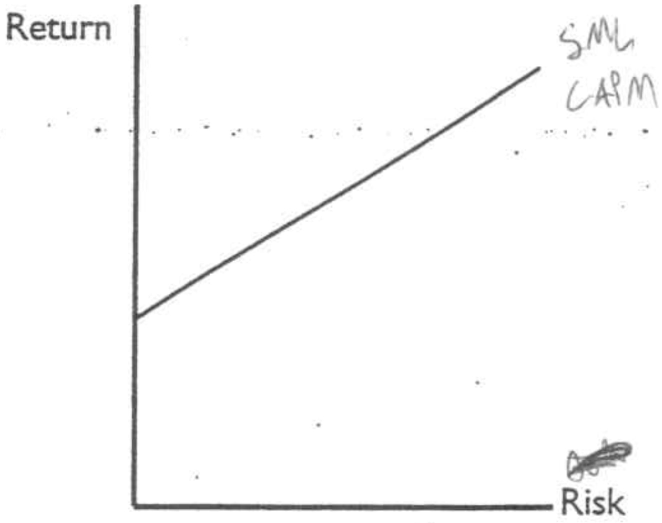
$\sigma = .3$

$\sigma_m = .2$

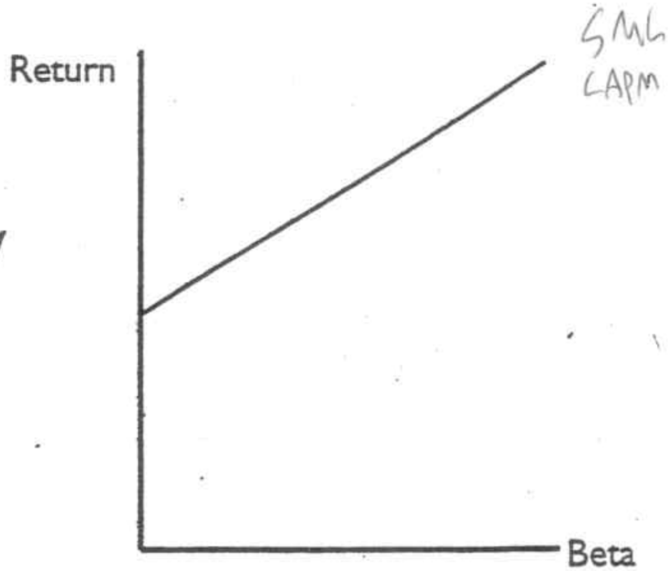
Calculate $\beta$

# Relationship Between Risk and Return

Common sense suggests that the expected return on a security is positively related to its risk



If beta is the appropriate measure of risk, the expected return on a security should be positively related to its beta



# Forecasting Rate of Return for the Market as a Whole

Expected return on market = Risk free rate + Historical risk premium

$E(R_M) = R_F +$ Historical risk premium

Example:

Risk-free rate is 4%
Historical risk premium from Ibbotson-Sinquefield data is 8.6%

12.6% = 4% + 8.6%

# Forecasting Rate of Return on Individual Stock

$$E(R_j) = R_F + \beta\,[\,E(R_M) - R_F\,]$$

Example:

Risk-free rate is 4%
Historical risk premium is 8.6%
Beta is 1.5

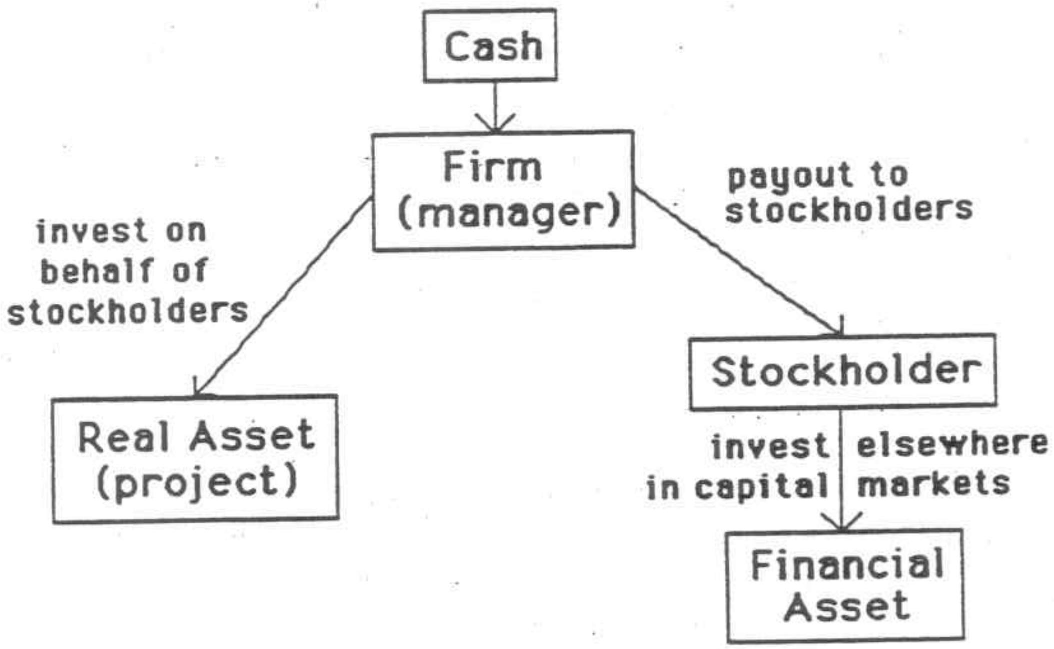
$$16.9\% = 4\% + 1.5\,[\,8.6\%\,]$$

## APPLICATION TO CAPITAL BUDGETING

We now know how to calculate the expected return on a stock.

We can use this information to determine the discount rate for a project.

You already saw this chart earlier in the course:



## THE BETA OF A PROJECT

A scale-enhancing project - A project that is similar to the whole firm. Therefore, it is assumed to have the firm's beta.

A non-scale enhancing project - A project that is not similar to the whole firm.

If a project's beta differs from that of the firm, the project should be discounted at the rate commensurate with its own beta. This is very important because firms frequently speak of a corporate discount rate. Unless all projects in the corporation are of the same risk, choosing the same discount rate for all projects is incorrect.

Note:

Firms and projects are generally financed by combinations of debt and equity. The beta of a whole firm or project can be viewed as a weighted average of the beta of the debt and the beta of the equity. Since the beta of debt is near zero, the beta of the firm (or project) is below the equity beta.

This must be taken into account when determining the discount rate for a project.

## DETERMINING A PROJECT'S COST OF CAPITAL

1. Find an industry that most mirrors the project

2. Calculate $r_A$ for each firm in industry

3. Calculate average $r_A$ for industry

4. Calculate $r_E$ and WACC for project

**EXAMPLE:**

General Motors has decided to manufacture widgets. GM plans to issue 50% debt and 50% equity to fund this project. Their only competitor is American Widgets with:

$\beta = 1$ $\quad\quad \frac{D}{V} = .4$ $\quad\quad \frac{E}{V} = .6$

$R_F$ is 10% and all firms borrow at that rate. The historical risk premium is 8.6% and the corporate tax rate is .34.

$r_E$ (American Widgets) $= R_F + (E(R_M) - R_F)\beta$

$$.186 = .10 + .086 \times 1$$

$r_E$ (American Widgets) $= r_A + D/E(1 - T_C)(r_A - r_D)$

$.186 = r_A + .4/.6\ (.66)(r_A - .10)$

$r_A$ (American Widgets) $= .160$

$r_E$ (GM's widget venture)$= r_A + D/E\ (1-T_C)(r_A - r_D)$

$.20 = .160 + 1/1\ (.66)(.160 - .10)$

WACC (GM's widget venture) $= D/V \times R_F\ (1- T_C) + E/V \times r_E$

$.133 = .5 \times .10(.66) + .5 \times .20$

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WHARTON REPROGRAPHICS

# Cases

Assignment #2

## NEW ECONOMY TRANSPORT COMPANY

### Case Assignment

Question: Would you recommend general overhaul of the Cynthia II, general overhaul plus upgrade of the boat, or purchase of the new boat?

In arriving at your answer, please make the following assumptions, in addition to the data presented in the case.

1. The new boat, if purchased, could be sold after 15 years of service for $400,000.
2. The costs of a new engine and electronic equipment must be depreciated, while hull repairs and maintenance may be expensed.
3. All depreciable items fall into the 5-year ACRS class.
4. The 10% investment tax credit is elected.
5. The decision with respect to overhaul or new boat purchase is implemented on 1/1/84, with the boat placed in service on 7/1/84.
6. If the Cynthia II is not sold, the full $70,000 of remaining book value may be depreciated in 1984.

Supplemental considerations: Sensitivity analysis

Would your decision to overhaul, overhaul and upgrade, or purchase a new boat be altered by changes in any of the following assumptions:

1. The new boat will generate additional revenues.
2. The new boat will involve additional shakedown costs.
3. The salvage value of the new boat is $400,000 in 15 years.
4. The new boat will necessitate additional training costs.

## NEW ECONOMY TRANSPORT COMPANY
(1983 version)

In October 1983, Graham Dodd, the controller of the New Economy Transport Company (NETCO), was evaluating a proposed $400,000 outlay for a new engine and general overhaul of the Cynthia II, one of the boats NETCO used to push barges up and down the Mississippi and Ohio Rivers. The Cynthia II had been purchased in 1950 by NETCO's predecessor, the Economy Shipping Co. [1].

Estimated costs of the overhaul were:

| | |
|---|---|
| 1. Install new engine and associated equipment | $185,000 |
| 2. Replace radar and other electronic equipment | 50,000 |
| 3. Repairs to hull and superstructure | 130,000 |
| 4. Painting and other maintenance | 35,000 |
| | $400,000 |

Only the first two items would qualify for the investment tax credit.

NETCO's chief engineer had estimated post-overhaul annual operating costs as follows:

| | |
|---|---|
| Fuel | $450,000 |
| Labor and benefits | 480,000 |
| Maintenance | 141,000 |
| Other | 110,000 |
| | $1,181,000 |

---

[1] The Cynthia II was the company's first diesel boat; the first Cynthia was a steam boat. The facts which led to the Cynthia II's purchase are described in the well-known Harvard Business School case, "Economy Shipping Co." (1966).

The operating costs given just above assumed a new boat would be operated in the same way that the Cynthia II would. But Mr. Dodd thought that a new boat might be able to push a larger load on some routes. This might generate additional revenues, net of additional out-of pocket costs, of as much as $100;000 per year.

Cohn and Doyle offered the new boat for a fixed price of $2,000,000, payable half immediately and half on delivery in June 1984 (3). Of this amount, $600,000 was for the engine and associated equipment, and $510,000 was for navigation, control and other electronic equipment.

NETCO is a public company with a large number of stockholders and no outstanding debt. The company has been consistently profitable in the past, and Mr. Dodd is confident that any of the alternatives could be financed with funds already available. In his view, an inflation rate of 5% and a nominal interest rate of 10% sound about right. Furthermore, he believes that a real discount rate of 12% is appropriate for the operating cash flows in the tugboat business.

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(3) It would take at least six months to overhaul the Cynthia II. The new engine would have to be paid for immediately. The other costs could be spread evenly over the repair period.

The Cynthia II was carried on NETCO's books at a net value of only $30,000, but she could probably be sold "as is," along with an extensive inventory of spare parts, for $100,000. The book value of the spare parts inventory was $40,000.

NETCO's chief engineer had also suggested installation of a more modern navigation and control system, which would cost an extra $200,000. This additional equipment would not substantially improve the Cynthia II's performance, but it would reduce annual fuel, labor and maintenance costs:

| | |
|---|---|
| Fuel | $420,000 |
| Labor and benefits | 405,000 |
| Maintenance | 70,000 |
| Other | 90,000 |
| | $985,000 |

There was no question that the Cynthia needed a new engine and general overhaul soon. However, Mr. Dodd felt it unwise to proceed without also considering the purchase of a new boat. Cohn and Doyle, Inc., a Wisconsin shipyard, had approached NETCO with a new design incorporating a Kort nozzle, extensively automated navigation and power control systems, and much more comfortable accomodations for the crew. Estimated annual operating costs of the new boat were [2]:

| | |
|---|---|
| Fuel | $370,000 |
| Labor and benefits | 330,000 |
| Maintenance | 70,000 |
| Other | 74,000 |
| | $844,000 |

Mr. Dodd thought that $50,000 to $100,000 would have to be spent training the new boat's crew to handle more complex and sophisticated equipment. On the other hand, a new boat would have a useful service life of 20 years or more. The Cynthia II, even if rehabilitated, could not last that long—probably only 15 years.

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[2] These figures were calculated assuming normal operations. They do not include extra costs often incurred when introducing new equipment. Mr. Dodd had found shakedown costs virtually impossible to estimate. He worried that they might be higher for the new boat than for the renovated Cynthia II.

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WHARTON REPROGRAPHICS

# SUPER PROJECT

1. Critically evaluate the methods General Foods uses to assess the desirability of its investment projects.

2. Convert the information provided in Exhibit 6 into after tax cash flows. For the Super Project, calculate the IRR and the NPV assuming a 10% required return on assets.

3. What are the relevant cash flows for General Foods to use in evaluating the Super Project? How should they treat:

   - test market costs
   - allocated facilities
   - overhead expenditures
   - erosion of Jell-O sales

4. Should they go ahead with the Super project?

## [illegible] PROJECT (?)

1. Critically evaluate the [illegible] methods General Foods used to assess the acceptability of its investment projects.

2. [illegible] the information provided in Exhibit 6 [illegible] the cash flows. For the Super project, calculate the IRR and the NPV assuming a 10% [illegible] on assets.

3. What are the relevant cash flows for General Foods to use in evaluating the Super project? How should they be treated?

   - test market expenses
   - [illegible] facilities
   - [illegible] overhead expenditures
   - erosion of Jell-O sales

4. Should [illegible] go ahead with the Super project?

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# The Super Project

In March 1967, Crosby Sanberg, manager-financial analysis at General Foods Corporation, told a casewriter, "What I learned about incremental analysis at the Business School doesn't always work." He was convinced that under some circumstances sunk costs were relevant to capital project evaluations. He was also concerned that financial and accounting systems did not provide an accurate estimate of incremental costs and revenues, and that this was one of the most difficult problems in measuring the value of capital investment proposals. Sanberg used the Super project[1] as an example.

Super was a new instant dessert, based on a flavored, water-soluble, agglomerated[2] powder. Although four flavors would be offered, it was estimated that chocolate would account for 80% of total sales.

General Foods was organized along product lines in the United States, with foreign operations under a separate division. Major U.S. product divisions included Post, Kool-Aid, Maxwell House, Jell-O, and Birds Eye. Financial data for General Foods are given in **Exhibits 1, 2, and 3.**

The $200,000 capital investment project request for Super involved $80,000 for building modifications and $120,000 for machinery and equipment. Modifications would be made to an existing building, where Jell-O was manufactured. Since available capacity of a Jell-O agglomerator would be used in the manufacture of Super, no cost for the key machine was included in the project. The $120,000 machinery and equipment item represented packaging machinery.

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*Lecturer Harold E. Wyman prepared this case as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation. This case was made possible by the cooperation of General Foods Corporation.*

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[1] The name and nature of this new product have been disguised to avoid the disclosure of confidential information.

[2] Agglomeration is a process by which the processed powder is passed through a steam bath and then dried. This fluffs up the powder particles and increases solubility.

Table A Dessert Market, August–September 1966 Compared with August–September 1965

| | Market Share (%) Aug.-Sept. 1966 | % Change From Aug.-Sept. 1965 | |
|---|---|---|---|
| | | Share | Volume |
| Jell-O | 19.0% | 3.6 | 40.0 |
| Tasty | 4.0 | 4.0 | (new) |
| Total powders | 25.3 | 7.6 | 62.0 |
| Pie fillings and cake mixes | 32.0 | -3.9 | (no change) |
| Ice cream | 42.7 | -3.4 | 5.0 |
| Total market | 100.0% | | 13.0 |

## The Market

A Nielsen survey indicated that powdered desserts constituted a significant and growing segment of the total dessert market, as shown in **Table A**. On the basis of test market experience, General Foods expected Super to capture a 10% share of the total dessert market. Eighty percent of this expected Super volume would come from growth in total market share or growth in the powders segment, and 20% would come from erosion of Jell-O sales.

### Production Facilities

Test market volume was packaged on an existing line, inadequate to handle long-run requirements. Filling and packaging equipment to be purchased had a capacity of 1.9 million units on a two-shift, five-day workweek basis. This represented considerable excess capacity, since 1968 requirements were expected to reach 1.1 million units, and the national potential was regarded as 1.6 million units. However, the extra capacity resulted from purchasing standard equipment, and a more economical alternative did not exist.

### Capital Budgeting Procedure

The General Foods Accounting and Financial Manual identified four categories of capital investment project proposals: (1) safety and convenience; (2) quality; (3) increase profit; and (4) other. Proposal procedures and criteria for accepting projects varied according to category (see **Exhibit 4**). In discussing these criteria, Sanberg noted that the payback and return guidelines were not used as cut-off measures and added:

> Payback and return on investment are rarely the only measure of acceptability. Criteria vary significantly by type of project. A relatively high return might be required for a new product in a new business category. On the other hand, a much lower return might be acceptable for a new product entry which represented a continuing effort to maintain leadership in an existing business by, for example, filling out the product line.

Super fell into the third category, as a profit-increasing project. Estimates of payback and return on funds employed were required for each such project requiring $50,000 or more of new capital funds and expense before taxes. The payback period was the length of time required for the project to repay the investment from the date the project became operational. In calculating the repayment period, only incremental income and expenses related to the project were used.

Return on funds employed (ROFE) was calculated by dividing 10-year average profit before taxes by the 10-year average funds employed. Funds employed included incremental net fixed assets plus or minus related working capital. Start-up costs and any profits or losses incurred before the project became operational were included in the first profit and loss period in the financial evaluation calculation.

### Capital Budgeting Atmosphere

A General Foods accounting executive commented on the atmosphere within which capital projects were reviewed:

> Our problem is not one of capital rationing. Our problem is to find enough good solid projects to employ capital at an attractive return on investment. Of course, the rate of capital inputs must be balanced against a steady growth in earnings per share. The short-term impact of capital investments is usually an increase in the capital base without an immediate realization of profit potential. This is particularly true in the case of new products.
>
> The food industry should show a continuous growth. A cyclical industry can afford to let its profits vary. We want to expand faster than the gross national product. The key to our capital budgeting is to integrate the plans of our eight divisions into a balanced company plan which meets our overall growth objectives. Most new products show a loss in the first two or three years, but our divisions are big enough to introduce new products without showing a loss.

### Documentation for the Super Project

**Exhibits 5** and **6** document the financial evaluation of the Super project. **Exhibit 5** is the summary appropriation request prepared to justify the project to management and to secure management's authorization to expend funds on a capital project. **Exhibit 6** presents the backup detail. Cost of the market test was included as "Other" expense in the first period because a new product had to pay for its test market expense, even though this might be a sunk cost at the time capital funds were requested. The "Adjustments" item represented erosion of the Jell-O market and was calculated by multiplying the volume of erosion times a variable profit contribution. In the preparation of this financial evaluation form, costs of acquiring packaging machinery were included but no cost was attributed to Jell-O agglomerator capacity to be used for the Super project because the General Foods Accounting and Financial Manual specified that capital project requests be prepared on an incremental basis:

> The incremental concept requires that project requests, profit projections, and funds-employed statements include only items of income and expense and investment in assets which will be realized, incurred, or made directly as a result of, or are attributed to, the new project.

### Exchange of Memos on the Super Project

After receiving the paperwork on the Super project, Sanberg studied the situation and wrote a memorandum arguing that the incremental approach advocated by the manual should not be applied to the Super project. His superior agreed with the memorandum and forwarded it to the corporate controller with the covering note contained in **Appendix A**. The controller's reply is given in **Appendix B**.

## Exhibit 1 Consolidated Balance Sheet of General Foods Corporation, Fiscal Year Ended April 1, 1967 ($ millions)

| | |
|---|---|
| **Assets** | |
| Cash | $ 20 |
| Marketable securities | 89 |
| Receivables | 180 |
| Inventories | 261 |
| Prepaid expenses | 14 |
| Current assets | 564 |
| Land, buildings, equipment (at cost, less depreciation) | 332 |
| Long-term receivables and sundry assets | 7 |
| Goodwill | 26 |
| Total | $929 |
| **Liabilities and Stockholders' Equity** | |
| Notes payable | $ 22 |
| Accounts payable | 86 |
| Accrued liabilities | 73 |
| Accrued income taxes | 57 |
| Current liabilities | 238 |
| Long-term notes | 39 |
| 3⅜% debentures | 22 |
| Other noncurrent liabilities | 10 |
| Deferred investment tax credit | 9 |
| Stockholders' equity | |
| Common stock issued | 164 |
| Retained earnings | 449 |
| Common stock held in treasury, at cost | (2) |
| Stockholders' equity | 611 |
| Total | $929 |
| Common stock–shares outstanding at year-end | 25,127,007 |

## Exhibit 2 Common Stock Prices of General Foods Corporation, 1958-1967

| Year | Low | High |
|---|---|---|
| 1958 | $24 | $ 39¾ |
| 1959 | 37⅝ | 53⅝ |
| 1960 | 49⅜ | 75½ |
| 1961 | 68⅝ | 107¾ |
| 1962 | 57¼ | 96 |
| 1963 | 77⅝ | 90½ |
| 1964 | 78¼ | 93¾ |
| 1965 | 77½ | 89⅝ |
| 1966 | 62¼ | 83 |
| 1967 | 65¼ | 81¾ |

**Exhibit 3** Summary of Statistical Data of General Foods Corporation, Fiscal Year 1958–1967 ($ millions, except assets per employee and figures on a share basis)

| | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Earnings** | | | | | | | | | | |
| Sales to customers (net) | $1,009 | $1,053 | $1,087 | $1,160 | $1,189 | $1,216 | $1,338 | $1,478 | $1,555 | $1,652 |
| Cost of sales | 724 | 734 | 725 | 764 | 769 | 769 | 838 | 937 | 965 | 1,012 |
| Marketing, administrative and general expenses | 181 | 205 | 236 | 261 | 267 | 274 | 322 | 362 | 406 | 449 |
| Earnings before income taxes | 105 | 115 | 130 | 138 | 156 | 170 | 179 | 177 | 185 | 193 |
| Taxes on income | 57 | 61 | 69 | 71 | 84 | 91 | 95 | 91 | 91 | 94 |
| Net earnings | $ 48 | $ 54 | $ 61 | $ 67 | $ 72 | $ 79 | $ 84 | $ 86 | $ 94 | $ 99 |
| Dividends on common shares | 24 | 28 | 32 | 35 | 40 | 45 | 50 | 50 | 53 | 55 |
| Retain earnings—current year | 24 | 26 | 29 | 32 | 32 | 34 | 34 | 36 | 41 | 44 |
| Net earnings per common share* | $1.99 | $2.21 | $2.48 | $2.69 | $2.90 | $3.14 | $3.33 | $3.44 | $3.73 | $3.93 |
| Dividends per common share* | 1.00 | 1.15 | 1.30 | 1.40 | 1.60 | 1.80 | 2.00 | 2.00 | 2.10 | 2.20 |
| **Assets, Liabilities, and Stockholders' Equity** | | | | | | | | | | |
| Inventories | 169 | 149 | 154 | 189 | 183 | 205 | 256 | 214 | 261 | 261 |
| Other current assets | 144 | 180 | 200 | 171 | 204 | 206 | 180 | 230 | 266 | 303 |
| Current liabilities | 107 | 107 | 126 | 123 | 142 | 162 | 202 | 173 | 219 | 238 |
| Working capital | 206 | 222 | 230 | 237 | 245 | 249 | 234 | 271 | 308 | 326 |
| Land, buildings, equipment, gross | 203 | 221 | 247 | 289 | 328 | 375 | 436 | 477 | 517 | 569 |
| Land, buildings, equipment, net | 125 | 132 | 148 | 173 | 193 | 233 | 264 | 283 | 308 | 332 |
| Long-term debt | 49 | 44 | 40 | 37 | 35 | 34 | 23 | 37 | 54 | 61 |
| Stockholders' equity | 287 | 315 | 347 | 384 | 419 | 454 | 490 | 527 | 569 | 611 |
| Stockholders' equity per common share* | 11.78 | 12.87 | 14.07 | 15.46 | 16.80 | 18.17 | 19.53 | 20.99 | 22.64 | 24.32 |
| **Capital Program** | | | | | | | | | | |
| Capital additions | 28 | 24 | 35 | 40 | 42 | 57 | 70 | 54 | 65 | 59 |
| Depreciation | 11 | 14 | 15 | 18 | 21 | 24 | 26 | 29 | 32 | 34 |
| **Employment Data** | | | | | | | | | | |
| Wages, salaries, and benefits | $128 | $138 | $147 | $162 | $171 | $180 | $195 | $204 | $218 | $237 |
| Number of employees (in thousands) | 21 | 22 | 22 | 25 | 28 | 28 | 30 | 30 | 30 | 32 |
| Assets per employee ($ thousands) | $21 | $22 | $23 | $22 | $22 | $23 | $24 | $25 | $29 | $29 |

*Per share figures calculated on shares outstanding at year-end and adjusted for 2-for-1 stock split in August 1960.

## Exhibit 4 Criteria for Evaluating Projects by General Foods Corporation

The basic criteria to be applied in evaluating projects within each of the classifications are set forth in the following schedule:

**Purpose of Project**

**a. Safety and Convenience:**

1. Projects required for reasons of safety, sanitation, health, public convenience, or other over-riding reason with no reasonable alternatives. Examples: sprinkler systems, elevators, fire escapes, smoke control, waste disposal, treatment of water pollution, etc.
2. Additional nonproductive space requirements for which there are no financial criteria. Examples: office space, laboratories, service areas (kitchens, restrooms, etc.).

**b. Quality:**

Projects designed primarily to improve quality.

**c. Increase Profit:**

1. Projects that are justified primarily by reduced costs.
2. Projects that are designed primarily to increase production capacity for an existing product.
3. Projects designed to provide facilities to manufacture and distribute a new product or product line.

**d. Other:**

This category includes projects which by definition are excluded from the three preceding categories. Examples: standby facilities intended to insure uninterrupted production, additional equipment not expected to improve profits or product quality and not required for reasons of safety and convenience, equipment to satisfy marketing requirements, etc.

**Payback and ROFE Criteria**

Payback—return on funds projections not required but the request must clearly demonstrate the *immediate* need for the project and the lack or inadequacy of alternative solutions.

Requests for nonproductive facilities, such as warehouses, laboratories, and offices should indicate the advantages of owning rather than leasing, unless no possibility to lease exists. In those cases where the company owns a group of integrated facilities and wherein the introduction of rented or leased properties might complicate the long-range planning or development of the area, owning rather than leasing is recommended. If the project is designed to improve customer service (such as market-centered warehouses) this factor is to be noted on the project request.

If Payback and ROFE cannot be computed, it must be clearly demonstrated that the improvement is identifiable and desirable.

Projects with a Payback period *up to 10 years* and a 10-year return *on* funds *as low as 20%* PBT are considered worthy of consideration, provided (1) the end product involved is believed to be a reasonably permanent part of our line or (2) the facilities involved are so flexible that they may be usable for successor products.

Projects for a proven product where the risk of mortality is small, such as coffee, Jell-O Gelatin, and cereals, should assure a payback in *no more than 10 years* and 10-year PBT return on funds of *no less* than 20%.

Because of the greater risk involved such projects should show a high potential return *on* funds (not less than a 10-year PBT return of 40%). Payback period, however, might be as much as *10 years* because of losses incurred during the market development period.[*]

While standards of return may be difficult to set, some calculations of financial benefits should be made where possible.

Source: The General Foods Accounting and Financial Manual

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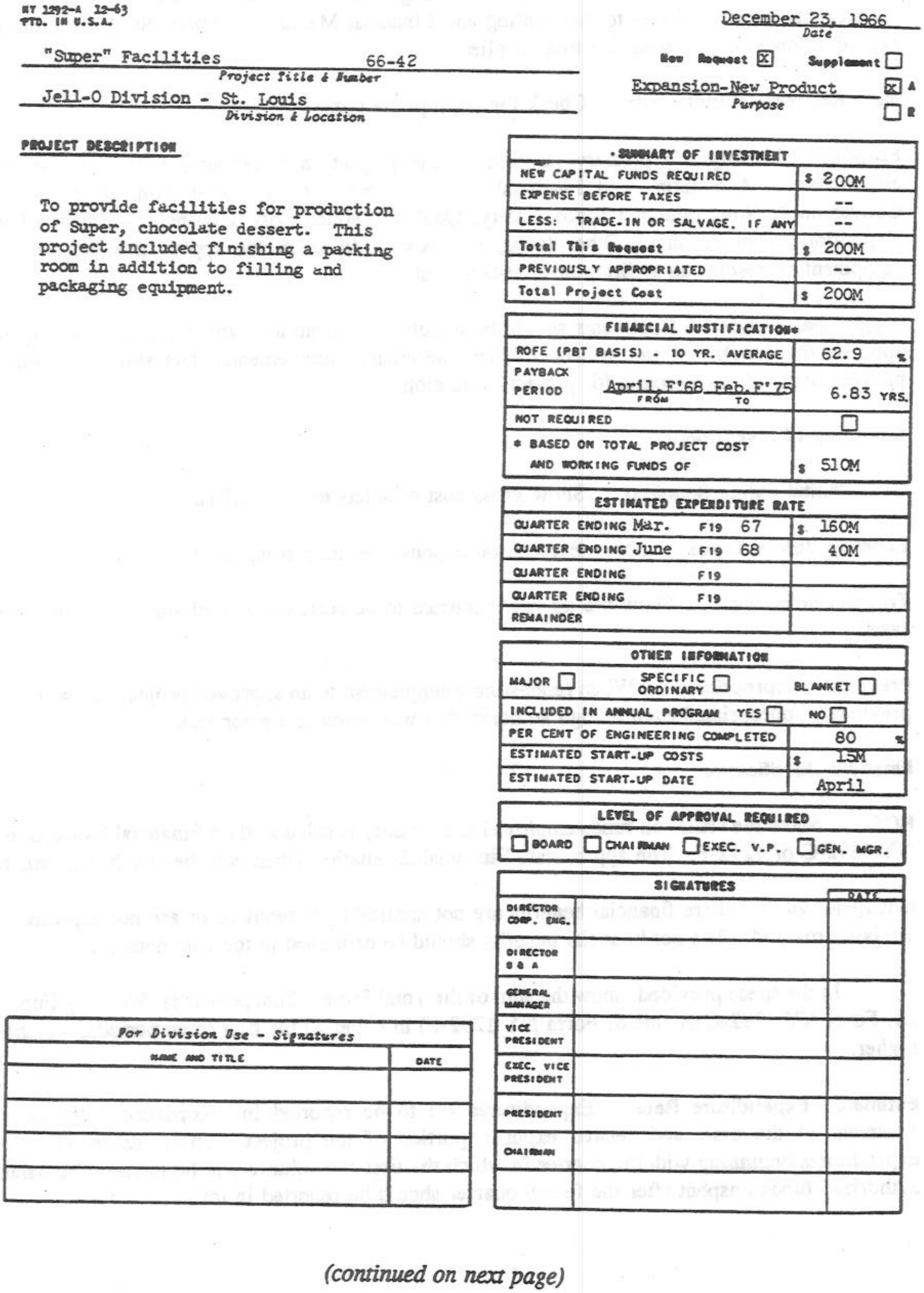
[*] These criteria apply to the United States and Canada only. Profit-increasing capital projects in other areas in categories c1 and c2 should offer at least a 10-year PBT return of 24% to compensate for the greater risk involved. Likewise, foreign operation projects in the c3 category should offer a 10-year PBT return of at least 48%.

## Exhibit 5 Capital Project Request Form of General Foods Corporation



NY 1292-A 12-63
PTD. IN U.S.A.

December 23, 1966
*Date*

"Super" Facilities 66-42
*Project Title & Number*

New Request ☒ Supplement ☐

Jell-O Division - St. Louis
*Division & Location*

Expansion-New Product ☒ A
*Purpose* ☐ R

**PROJECT DESCRIPTION**

To provide facilities for production of Super, chocolate dessert. This project included finishing a packing room in addition to filling and packaging equipment.

| ·SUMMARY OF INVESTMENT | |
|---|---|
| NEW CAPITAL FUNDS REQUIRED | $ 200M |
| EXPENSE BEFORE TAXES | -- |
| LESS: TRADE-IN OR SALVAGE, IF ANY | -- |
| Total This Request | $ 200M |
| PREVIOUSLY APPROPRIATED | -- |
| Total Project Cost | $ 200M |

| FINANCIAL JUSTIFICATION* | |
|---|---|
| ROFE (PBT BASIS) - 10 YR. AVERAGE | 62.9 % |
| PAYBACK PERIOD April F'68 Feb. F'75 (FROM / TO) | 6.83 YRS. |
| NOT REQUIRED | ☐ |
| * BASED ON TOTAL PROJECT COST AND WORKING FUNDS OF | $ 510M |

| ESTIMATED EXPENDITURE RATE | |
|---|---|
| QUARTER ENDING Mar. F19 67 | $ 160M |
| QUARTER ENDING June F19 68 | 40M |
| QUARTER ENDING F19 | |
| QUARTER ENDING F19 | |
| REMAINDER | |

| OTHER INFORMATION | |
|---|---|
| MAJOR ☐ SPECIFIC ORDINARY ☐ BLANKET ☐ | |
| INCLUDED IN ANNUAL PROGRAM YES ☐ NO ☐ | |
| PER CENT OF ENGINEERING COMPLETED | 80 % |
| ESTIMATED START-UP COSTS | $ 15M |
| ESTIMATED START-UP DATE | April |

**LEVEL OF APPROVAL REQUIRED**

☐ BOARD ☐ CHAIRMAN ☐ EXEC. V.P. ☐ GEN. MGR.

| SIGNATURES | | DATE |
|---|---|---|
| DIRECTOR CORP. ENG. | | |
| DIRECTOR S & A | | |
| GENERAL MANAGER | | |
| VICE PRESIDENT | | |
| EXEC. VICE PRESIDENT | | |
| PRESIDENT | | |
| CHAIRMAN | | |

| *For Division Use - Signatures* | |
|---|---|
| NAME AND TITLE | DATE |
| | |
| | |
| | |
| | |

*(continued on next page)*

**Exhibit 5 (continued)** Instructions for Capital Project Request Form NY 1292-A

The purpose of this form is to secure management's authorization to commit or expend funds on a capital project. Refer to Accounting and Financial Manual Statement No. 19 for information regarding projects to which this form applies.

**New Request—Supplement** Check the appropriate box.

**Purpose** Identify the primary purpose of the project in accordance with the classifications established in Accounting and Financial Statement No. 19, i.e., Sanitation, Health and Public Convenience, Nonproductive Space, Safety, Quality, Reduce Cost, Expansion—Existing Products, Expansion—New Products, Other (specify). Also indicate in the appropriate box whether the equipment represents an addition or a replacement.

**Project Description** Comments should be in sufficient detail to enable Corporate Management to appraise the benefits of the project. Where necessary, supplemental data should be attached to provide complete background for project evaluation.

**Summary of Investment**

**New Capital Funds Required** Show gross cost of assets to be acquired.

**Expense Before Taxes** Show incremental expense resulting from project.

**Trade-in or Salvage** Show the amount expected to be realized on trade-in or sale of a replaced asset.

**Previously Appropriated** When requesting a supplement to an approved project, show the amount previously appropriated even though authorization was given in a prior year.

**Financial Justification**

**ROFE** Show the return on funds employed (PBT basis) as calculated on Financial Evaluation Form NY 1292-C or 1292-F. The appropriate Financial Evaluation Form is to be attached to this form.

**Not Required** Where financial benefits are not applicable or required or are not expected, check the box provided. The nonfinancial benefits should be explained in the comments.

In the space provided, show the sum of the Total Project Cost plus Total Working Funds (line 20, Form NY 1292-C or line 5, Form NY 1292-F) in either of the first three periods, whichever is higher.

**Estimated Expenditure Rate** Expenditures are to be reported in accordance with accounting treatment of the asset and related expense portion of the project. Insert estimated quarterly expenditures beginning with the quarter in which the first expenditure will be made. The balance of authorized funds unspent after the fourth quarter should be reported in total.

## Exhibit 5 (continued)

**Other Information** Check whether the project is a major, specific ordinary, or blanket, and whether or not the project was included in the Annual Program. Show estimated percentage of engineering completed; this is intended to give management an indication of the degree of reliability of the funds requested. Indicate the estimated start-up costs as shown on line 32 of Financial Evaluation Form NY 1292-C. Insert anticipated start-up date for the project; if start-up is to be staggered, explain in the comments.

**Level of Approval Required** Check the appropriate box.

Source: General Foods

**Exhibit 6** Financial Evaluation Form of General Foods Corporation ($ in thousands)

NY 1252-C 10-64
PTD. IN U.S.A.

| | | | | |
|---|---|---|---|---|
| Jell-O | St. Louis | The Super Project | 67-89 | |
| Division | Location | Project Title | Project No. | Date |
| | | | | Supplement No. |

| Project Request Detail | 1st Per. | 2nd Per. | ___ Per. | ___ Per. | ___ Per. |
|---|---|---|---|---|---|
| 1. Land | $ | | | | |
| 2. Buildings | 80 | | | | |
| 3. Machinery & Equipment | 120 | | | | |
| 4. Engineering | | | | | |
| 5. Other (Explain) | | | | | |
| 6. Expense Portion (Before Tax) | | | | | |
| 7. Sub-Total | $ 200 | | | | |
| 8. Less: Salvage Value (Old Asset) | | | | | |
| 9. Total Project Cost* | $ 200 | | | | |
| 10. Less: Taxes on Exp. Portion | | | | | |
| 11. Net Project Cost | $ 200 | | | | |

* Same as Project Request

**RETURN ON NEW FUNDS EMPLOYED - 10-YR. AVG.**

| | PAT (C ÷ A) | PBT (B ÷ A) |
|---|---|---|
| A - New Funds Employed (Line 21) | $ 380 | $ 380 |
| B - Profit Before Taxes (Line 35) | ▨ | $ 239 |
| C - Net Profit (Line 37) | $ 115 | ▨ |
| D - Calculated Return | 30.2 % | 62.0 % |

**PAYBACK YEARS FROM OPERATIONAL DATE**

| | | |
|---|---|---|
| Part Year Calculation for First Period | - | Yrs. |
| Number of Full Years to Pay Back | 6.00 | Yrs. |
| Part Year Calculation for Last Period | 0.83 | Yrs. |
| Total Years to Pay Back | 6.83 | Yrs. |

| Funds Employed | 1st Per. F 68 | 2nd Per. F 69 | 3rd Per. F 70 | 4th Per. F 71 | 5th Per. F 72 | 6th Per. F 73 | 7th Per. F 74 | 8th Per. F 75 | 9th Per. F 76 | 10th Per. F 77 | 11th Per. ___ | 10-Yr. Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12. Net Project Cost (Line 11) | $ 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | ▨ | ▨ |
| 13. Deduct Depreciation (Cum.) | 19 | 37 | 54 | 70 | 85 | 98 | 110 | 121 | 131 | 140 | ▨ | ▨ |
| 14. Capital Funds Employed | $ 181 | 163 | 146 | 130 | 115 | 102 | 90 | 79 | 69 | 60 | ▨ | 113 |
| 15. Cash | | | | | | | | | | | ▨ | |
| 16. Receivables | 124 | 134 | 142 | 157 | 160 | 160 | 169 | 169 | 178 | 178 | ▨ | 157 |
| 17. Inventories | 207 | 222 | 237 | 251 | 266 | 266 | 281 | 281 | 296 | 296 | ▨ | 260 |
| 18. Prepaid & Deferred Exp. | | | | | | | | | | | ▨ | |
| 19. Less Current Liabilities | (2) | (82) | (108) | (138) | (185) | (184) | (195) | (195) | (207) | (207) | ▨ | (150) |
| 20. Total Working Funds (15 thru 19) | 329 | 274 | 271 | 264 | 241 | 242 | 255 | 255 | 267 | 267 | ▨ | 267 |
| 21. Total New Funds Employed (14 + 20) | $ 510 | 437 | 417 | 394 | 356 | 344 | 345 | 334 | 336 | 327 | ▨ | 380 |

| Profit and Loss | 1st Per. F 68 | 2nd Per. F 69 | 3rd Per. F 70 | 4th Per. F 71 | 5th Per. F 72 | 6th Per. F 73 | 7th Per. F 74 | 8th Per. F 75 | 9th Per. F 76 | 10th Per. F 77 | 11th Per. ___ | 10-Yr. Avg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22. Unit Volume (in thousands) | 1100 | 1200 | 1300 | 1400 | 1500 | 1500 | 1600 | 1600 | 1700 | 1700 | | 1460 |
| 23. Gross Sales | $ 2200 | 2400 | 2600 | 2800 | 3000 | 3000 | 3200 | 3200 | 3400 | 3400 | | 2920 |
| 24. Deductions | 88 | 96 | 104 | 112 | 120 | 120 | 128 | 128 | 136 | 136 | | 117 |
| 25. Net Sales | 2112 | 2304 | 2496 | 2688 | 2880 | 2880 | 3072 | 3072 | 3264 | 3264 | | 2803 |
| 26. Cost of Goods Sold | 1100 | 1200 | 1300 | 1400 | 1500 | 1500 | 1600 | 1600 | 1700 | 1700 | | 1460 |
| 27. Gross Profit | 1012 | 1104 | 1196 | 1288 | 1380 | 1380 | 1472 | 1472 | 1564 | 1564 | | 1343 |
| Gross Profit % Net Sales | % | | | | | | | | | | | |
| 28. Advertising Expense | | | | | | | | | | | | |
| 29. Selling Expense | 1100 | 1050 | 1000 | 900 | 700 | 700 | 730 | 730 | 750 | 750 | | 841 |
| 30. Gen. and Admin. Costs | | | | | | | | | | | | |
| 31. Research Expense | | | | | | | | | | | | |
| 32. Start-up Costs | 15 | | | | | | | | | | | 2 |
| 33. Other (Explain) Test Mkt. | 360 | | | | | | | | | | | 36 |
| 34. Adjustments (Explain) Erosion | 180 | 200 | 210 | 220 | 230 | 230 | 240 | 240 | 250 | 250 | | 225 |
| 35. Profit Before Taxes | $ (643) | (146) | (14) | 168 | 450 | 450 | 502 | 502 | 564 | 564 | | 239 |
| 36. Taxes | (334) | (76) | (7) | 87 | 234 | 234 | 261 | 261 | 293 | 293 | | 125 |
| 36A. Add: Investment Credit | (1) | (1) | (1) | (1) | (1) | (1) | (1) | (1) | - | - | | (1) |
| 37. Net Profit | (308) | (69) | (6) | 82 | 217 | 217 | 242 | 242 | 271 | 271 | | 115 |
| 38. Cumulative Net Profit | $ (308) | (377) | (383) | (301) | (84) | 133 | 375 | 617 | 888 | 1159 | | |
| 39. New Funds to Repay (21 less 38) | $ 818 | 814 | 800 | 695 | 440 | 211 | (30) | (283) | (552) | (832) | | |

*See Accounting & Financial Manual Policy No. 19 for Instructions.*

(Continued on next page)

**Exhibit 6 (continued)** Instructions for Preparation of Form NY 1292-C Financial Evaluation

This form is to be submitted to Corporate Budget and Analysis with each profit-increasing capital project request requiring $50,000 or more of capital funds and expense before taxes.

Note that the 10-year term has been divided into 11 periods. The first period is to end on the March 31 following the operational date of the project, and the P&L projection may thereby encompass any number of months from 1 to 12, e.g., if the project becomes operational on November 1, 1964, the first period for P&L purposes would be 5 months (November 1, 1964 through March 31, 1965). The next nine periods would be fiscal years (F '66, F '67, etc.) and the 11th period would be 7 months (April 1, 1974 through October 30, 1974). This has been done primarily to facilitate reporting of projected and actual P&L data by providing for fiscal years. See categorized instructions below for more specific details.

**Project Request Detail** *Lines 1 through 11* show the breakdown of the Net Project Cost to be used in the financial evaluation. *Line 8* is to show the amount expected to be realized on trade-in or sale of a replaced asset. *Line 9* should be the same as the "Total Project Cost" shown on Form NY 1292-A, Capital Project Request. Space has been provided for capital expenditures related to this project which are projected to take place subsequent to the first period. Indicate in such space the additional cost only; do not accumulate them.

**Funds Employed**

**Capital Funds Employed** *Line 12* will show the net project cost appearing on line 11 as a constant for the first 10 periods except in any period in which additional expenditures are incurred; in that event show the accumulated amount of line 11 in such period and in all future periods.

Deduct cumulative depreciation on *Line 13*. Depreciation is to be computed on an incremental basis, i.e., the net increase in depreciation over present depreciation on assets being replaced. In the first period depreciation will be computed at one half of the first year's annual rate; no depreciation is to be taken in the 11th period. Depreciation rates are to be the same as those used for accounting purposes. *Exception:* When the depreciation rate used for accounting purposes differs materially from the rate for tax purposes, the higher rate should be used. A variation will be considered material when the first full year's depreciation on a book basis varies 20% or more from the first full year's depreciation on a tax basis.

The 10-year average of Capital Funds Employed shall be computed by adding line 14 in each of the first 10 periods and then dividing the total by 10.

**Total Working Funds** Refer to Financial Policy No. 21 as a guide in computing new working fund requirements. Items which are not on a formula basis and which are normally computed on a five-quarter average shall be handled proportionately in the first period. For example, since the period involved may be less than 12 months, the average would be computed on the number of quarters involved. Generally, the balances should be approximately the same as they would be if the first period were a full year.

Cash, based on a formula which theorizes a two weeks' supply (2/52nds), should follow the same theory. If the first period is for three months, two-thirteenths (2/13th) should be used; if it is for five months, two-twenty-firsts (2/21sts) should be used, and so forth.

**Exhibit 6 (continued)**

Current liabilities are to include one-half of the tax expense as the tax liability. The 10-year averages of Working Funds shall be computed by adding each line across or the first 10 periods and then dividing each total by 10.

### Profit and Loss Projection

**P&L Categories (Lines 22 through 37)** Reflect only the incremental amounts which will result from the proposed project; exclude all allocated charges. Include the P&L results expected in the individual periods comprising the first 10 years of the life of the project. Refer to the second paragraph of these instructions regarding the fractional years' calculations during the first and eleventh periods.

Any loss or gain on the sale of a replaced asset (see line 8) shall be included on line 33.

As indicated in the caption Capital Funds Employed, no depreciation is to be taken in the eleventh period.

The 10-year averages of the P&L items shall be computed by adding each line across for the 11 periods (10 full years from the operational date) and dividing the total by 10.

**Adjustments (Line 34)** Show the adjustment necessary, on a before-tax basis, to indicate any adverse or favorable incremental effect the proposed project will have on any other products currently being produced by the corporation.

**Investment Credit** is to be included on line 36-A. The Investment Credit will be spread over 8 years, or fractions thereof, as an addition to PAT.

**Return on New Funds Employed** Ten-year average returns are to be calculated for PAT (projects requiring Board approval only) and PBT. The PAT return is calculated by dividing average PAT (line 37) by average new funds employed (line 21); the PBT return is derived by dividing average PBT (line 35) by average new funds employed (line 21).

### Payback Years From Operational Date

**Part Year Calculation for First Period** Divide number of months in the first period by 12. If five months are involved, the calculation is 5/12 = 0.4 years.

**Number of Full Years to Payback** Determined by the last period, excluding the first period, in which an amount is shown on line 39.

**Part Year Calculation for Last Period** Divide amount still to be repaid at the end of the last full period (line 39) by net profit plus the *annual* depreciation in the following year when payback is completed.

**Total Years to Payback** Sum of full and part years.

## Appendix A Memos to Controller

To: J. C. Kresslin, Corporate Controller

From: J. E. Hooting, Director, Corporate Budgets and Analysis

March 2, 1967

**Super Project**

At the time we reviewed the Super project, I indicated to you that the return on investment looked significantly different if an allocation of the agglomerator and building, originally justified as a Jell-O project, were included in the Super investment. The pro rata allocation of these facilities, based on the share of capacity used, triples the initial gross investment in Super facilities from $200,000 to about $672,000.

I am forwarding a memorandum from Crosby Sanberg summarizing the results of three analyses evaluating the project on an:

I. Incremental basis
II. Facilities-used basis
III. Fully allocated facilities and costs basis

Crosby has calculated a 10-year average ROFE using these techniques. Please read Crosby's memo before continuing with my note.

* * * * *

Crosby concludes that the fully allocated basis, or some variation of it, is necessary to understand the long-range potential of the project.

I agree. We launch a new project because of its potential to increase our sales and earning power for many years into the future. We must be mindful of short-term consequences, as indicated by an incremental analysis, but we must also have a long-range frame of reference if we are to really understand what we are committing ourselves to. This long-range frame of reference is best approximated by looking at fully allocated investment and "accounted" profits, which recognize fully allocated costs because, in fact, over the long run all costs are variable unless some major change occurs in the structure of the business.

Our current GF preoccupation with only the incremental costs and investment causes some real anomalies that confuse our decision making. Super is a good example. On an incremental basis the project looks particularly attractive because by using a share of the excess capacity built on the coattails of the lucrative Jell-O project, the incremental investment in Super is low. If the excess Jell-O capacity did not exist, would the project be any less attractive? In the short term, perhaps yes because it would entail higher initial risk, but in the long term it is not a better project just because it fits a facility that is temporarily unused.

Looking at this point from a different angle, if the project exceeded our investment hurdle rate on a short-term basis but fell below it on a long-term basis (and Super comes close to doing this), should we reject the project? I say yes because over the long run, as "fixed" costs become variable and as we have to commit new capital to support the business, the continuing ROFE will go under water.

In sum, we have to look at new project proposals from both the long-range and the short-term point of view. We plan to refine our techniques of using a fully allocated basis as a long-term point of reference and will hammer out a policy recommendation for your consideration. We would appreciate any comments you may have.

**Appendix A (continued)** Memos to Controller

To: J. E. Hooting, Director, Corporate Budgets and Analysis

From: C. Sanberg, Manager, Financial Analysis

February 17, 1967

### Super Project: A Case Example of Investment Evaluation Techniques

This will review the merits of alternative techniques of evaluating capital investment decisions using the Super project as an example. The purpose of the review is to provide an illustration of the problems and limitations inherent in using incremental ROFE and payback and thereby provide a rationale for adopting new techniques.

### Alternative Techniques

The alternative techniques to be reviewed are differentiated by the level of revenue and investment charged to the Super project in figuring a payback and ROFE, starting with incremental revenues and investment. Data related to the alternative techniques outlined below are summarized [at the end of this memo].

## Alternative 1. Incremental Basis

**Method** The Super project as originally evaluated considered only incremental revenue and investment, which could be directly identified with the decision to produce Super. Incremental fixed capital ($200M) basically included packaging equipment.

**Result** On this basis the project paid back in 7 years with a ROFE of 63%.

**Discussion** Although it is General Foods' current policy to evaluate capital projects on an incremental basis, this technique does not apply to the Super project. The reason is that Super extensively utilizes existing facilities, which are readily adaptable to known future alternative uses.

Super should be charged with the "opportunity loss" of agglomerating capacity and building space. Because of Super the opportunity is lost to use a portion of agglomerating capacity for Jell-O and other products that could potentially be agglomerated. In addition, the opportunity is lost to use the building space for existing or new product volume expansion. To the extent there is an opportunity loss of existing facilities, new facilities must be built to accommodate future expansion. In other words, because the business is expanding Super utilizes facilities that are adaptable to predictable alternative uses.

**Appendix A (continued)**

## Alternative II. Facilities-Used Basis

**Method** Recognizing that Super will use half of an existing agglomerator and two-thirds of an existing building, which were justified earlier in the Jell-O project, we added Super's pro rata share of these facilities ($453M) to the incremental capital. Overhead costs directly related to these existing facilities were also subtracted from incremental revenue on a shared basis.

**Result** ROFE 34%

**Discussion** Although the existing facilities utilized by Super are not incremental to this project, they are relevant to the evaluation of the project because potentially they can be put to alternative uses. Despite a high return on an incremental basis, if the ROFE on a project was unattractive after consideration of the shared use of existing facilities, the project would be questionable. Under these circumstances, we might look for a more profitable product for the facilities.

In summary, the facilities-used basis is a useful way of putting various projects on a common ground for purposes of *relative* evaluation. One product using existing capacity should not necessarily be judged to be more attractive than another practically identical product which necessitates an investment in additional facilities.

## Alternative III. Fully Allocated Basis

**Method** Further recognizing that individual decisions to expand inevitably add to a higher overhead base, we increased the costs and investment base developed in Alternative II by a provision for overhead expenses and overhead capital. These increases were made in year five of the 10-year evaluation period, on the theory that at this point a number of decisions would result in more fixed costs and facilities. Overhead expenses included manufacturing costs, plus selling and general and administrative costs on a per unit basis equivalent to Jell-O. Overhead capital included a share of the distribution system assets ($40M).

**Result** ROFE 25%

**Discussion** Charging Super with an overhead burden recognizes that overhead costs in the long run increase in proportion to the level of business activity, even though decisions to spend more overhead dollars are made separately from decisions to increase volume and provide the incremental facilities to support the higher volume level. To illustrate, the Division-F1968 Financial Plan budgets about a 75% increase in headquarters' overhead spending in F1968 over F1964. A contributing factor was the decision to increase the sales force by 50% to meet the demands of a growing and increasingly complex business. To further illustrate, about half the capital projects in the F1968 three-year Financial Plan are in the "non-payback" category. This group of projects comprised largely "overhead facilities" (warehouses, utilities, etc.), which are not directly related to the manufacture of products but are necessary components of the total business activity as a result of the cumulative effect of many decisions taken in the past.

*(continued on next page)*

## Appendix A (continued)

The Super project is a significant decision which will most likely add to more overhead dollars as illustrated above. Super volume doubles the powdered dessert business category; it increases the Division businesses by 10%. Furthermore, Super requires a new production technology: agglomeration and packaging on a high-speed line.

## Conclusions

1. The incremental basis for evaluating a project is an inadequate measure of a project's worth when existing facilities with a known future use will be utilized extensively.
2. A fully allocated basis of reviewing major new product proposals recognizes that overheads increase in proportion to the size and complexity of the business and provides the best long-range projection of the financial consequences.

Alternative Evaluations of Super Project ($ in thousands)

| Basis | I. Incremental Basis | II. Facilities-Used Basis | III. Fully Allocated |
|---|---|---|---|
| **Investment** | | | |
| Working capital | $267 | $267 | $267 |
| Fixed capital | | | |
| Gross | 200 | 653 | 672 |
| Net | 113 | 358 | 367 |
| Total net investment | 380 | 625 | 634 |
| Profit before taxes[a] | 239 | 211 | 157 |
| ROFE | 63% | 34% | 25% |
| Jell-O project | | | |
| Building | $200 x ⅔ = $133 | | |
| Agglomerator | 640 x ½ = 320 | | |
| | $453 | | |

Note: Figures based on 10-year averages.

[a] Assumes 20% of Super volume will replace existing Jell-O business.

## **Appendix B** Controller's Reply

To: Mr. J. F. Hooting, Director, Corporate Budgets and Analysis

From: Mr. J. C. Kresslin, Corporate Controller

Subject: Super Project

March 7, 1967

On March 2 you sent me a note describing Crosby Sanberg's and your thoughts about evaluating the Super project. In this memo you suggest that the project should be appraised on the basis of fully allocated facilities and production costs.

In order to continue the dialogue, I am raising a couple of questions below.

It seems to me that in a situation such as you describe for Super, the real question is a *management decision* as to whether to go ahead with the Super project or not go ahead. Or to put it another way, are we better off in the aggregate if we use half the agglomerator and two-thirds of an existing building for Super, or are we not, on the basis of our current knowledge?

It might be assumed that, for example, half of the agglomerator is being used and half is not and that a minimum economical size agglomerator was necessary for Jell-O and, consequently, should be justified by the Jell-O project itself. If we find a way to utilize it sooner by producing Super on it, aren't we better off in the aggregate, and the different ROFE figure for the Super project by itself becomes somewhat irrelevant? A similar point of view might be applied to the portion of the building. Or if we charge the Super project with half an agglomerator and two-thirds of an existing building, should we then go back and relieve the Jell-O projects of these costs in evaluating the management's original proposal?

To put it another way, since we are faced with making decisions at a certain time on the basis of what we then know, I see very little value in looking at the Super project all by itself. Better we should look at the total situation before and after to see how we fare.

As to allocated production costs, the point is not so clear. Undoubtedly, over the long haul, the selling prices will need to be determined on the basis of a satisfactory margin over fully allocated costs. Perhaps this should be an additional requirement in the course of evaluating capital projects, since we seem to have been surprised at the low margins for "Tasty" after allocating all costs to the product.

I look forward to discussing this subject with you and with Crosby at some length.

# CENTRAL EXPRESS

14

WHARTON REPROGRAPHICS

1. As Ms. Thorp, evaluate the relative attractiveness of the bond issue and of the common stock issue using Exhibit 3.

2. Critically analyze the directors' comments at the May directors' meeting concerning the choice between debt and equity financing.

3. Calculate the required return on equity currently implied by the valuation of Central Express' common shares in the market.

4. Calculate the APV of the Midland acquisition if the transaction is 100%-equity financed.

5. Calculate the APV of the Midland acquisition if the transaction is 100%-debt financed. (Assume that the sinking fund payments on the loan can be re-financed with debt at the original interest rate, i.e., the $10 million debt level is permanent.)

6. What is the optimal investment and financing policy for Central Express?

Harvard Business School

9-174-001
Rev. 8/87

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# CENTRAL EXPRESS CORPORATION

In May 1973, Elizabeth Thorp, treasurer of Central Express Corporation, was considering advantages and disadvantages of several alternative methods of financing Central's acquisition of Midland Freight, Inc. At a recent meeting of the board of directors, there had been substantial disagreement as to the best method of financing the acquisition. After the meeting Ms. Thorp had been asked by John Evans, president of Central, to assess the arguments presented by the various directors and to outline a position to be taken by the management at the June directors' meeting.

Central Express was a regulated general commodities motor carrier whose routes ran the length of the Pacific Coast, from Oregon and California to the industrial Midwest, and from Chicago to several Texas points. Founded in 1932 by three brothers, the firm had experienced little growth until the early 1960s. At that point Mr. Evans had joined the firm as president after many years as an executive of a major eastern carrier. Mr. Evans had first concentrated his efforts on expanding Central's revenues on existing routes through an intensive marketing effort and a renewed emphasis on improving service. In 1967, utilizing the proceeds of Central's initial public offering of common stock, Mr. Evans had begun a program designed to reduce operating costs through a combination of extensive computerization of operations and improvement in terminal facilities. As a result of these changes, Central had become a large and profitable concern, widely respected in the industry for its aggressive management.

In 1973, Mr. Evans and the directors of the firm had come to the conclusion that the key to continued expansion in revenues and income was a policy of selected acquisitions. After a study of potential candidates for acquisition, negotiations had begun with Midland Freight, Inc., a common carrier serving Michigan and Indiana from Chicago. The owners of Midland had agreed to sell the firm to Central for $10 million in cash. Mr. Evans felt that Midland was an outstanding acquisition in that it would expand Central's route system and seemed well suited for the type of marketing and cost reduction programs that had fostered Central's growth. The board had unanimously approved the merger.

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This case was prepared by Steven E. Levy, Research Assistant, under the supervision of Assistant Professor M. Edgar Barrett, as the basis for class discussion. It is not designed to illustrate either effective or ineffective handling of an administrative situation.

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Central's lawyers felt that no difficulty would be encountered in gaining the approval of the Interstate Commerce Commission for the merger, and the closing date for the acquisition was set for October 1, 1973. Mr. Evans realized that the funds for the Midland acquisition would have to be raised from outside sources. Given that Midland would add $1,680,000 in earnings before interest and taxes (EBIT) to Central on an annual basis, he felt that such external financing would not be difficult to obtain.

The management had followed a consistent policy of avoiding long-term debt. The company had met its needs through use of retained earnings supplemented with the proceeds of the 1967 stock offering and infrequent short-term bank loans. As of 1973, Central's capitalization consisted of common stock and surplus with no fixed debt of any kind. The common stock was held in large amounts by the management. While the stock was widely distributed, there was no real dominant interest other than management. The shares were transferred infrequently and were traded over the counter. Discussions with an investment banker led Ms. Thorp to believe that, barring a major market decline, common stock could be sold to the public at $26.50 a share. After underwriting fees and expenses, the net proceeds to the company would be $25.00 a share. Thus, if common stock was used, the acquisition would require issuance of 400,000 shares.

For the past few years, Ms. Thorp and Mr. Evans had been disappointed in the market performance of Central common stock (see Exhibit 1). Thus, they had decided to reconsider the firm's policy of avoiding long-term debt (see Exhibit 2). It was felt that such a change might be justified by the anticipated stability of Central's future earnings. Ms. Thorp had determined that the firm could sell $10 million in bonds to a California insurance company. The interest rate on these bonds would be 8% and they would mature in 15 years. An annual sinking fund of $500,000 would be required, leaving $2,500,000 outstanding at maturity. Although the bond terms would create a sizable need for cash, Ms. Thorp felt that they were the best that could be obtained.

In addition, Ms. Thorp had calculated that, given the tax deductibility of bond interest and Central's current effective tax rate of 50%, the 8% rate was the equivalent of 4% on an after-tax basis. In contrast, she felt that the stock at $25 a share and a dividend of $2.00 a share would cost Central 8%. This cost comparison made the debt alternative seem desirable to Ms. Thorp.

At the May directors' meeting, the Midland acquisition received enthusiastic approval. Ms. Thorp then decided to sound out the board as to their sentiments regarding the possibility of financing the acquisition with long-term debt rather than with common stock. She presented the foregoing cost calculations. To her concern, an acrimonious debate broke out among all the directors concerning financing policy.

Ms. Thorp was immediately questioned as to the cost of the debt issue, since her figures did not include the annual payment to the sinking fund. One director argued that this represented 8% of the average size of the bond issue over its 15-year life, and he felt that the stock issue had a smaller cost than the bonds. In addition, he emphasized the cash outlay called for in the bond alternative and the $2,500,000 maturity, especially in view of Central's already existing lease commitments. He felt that the use of debt thus added risks to the company, making the common stock more speculative and causing greater variation in market price.

Another director argued for the issuance of common stock because "simple arithmetic" showed that Central would net 8.4% or $840,000 a year after taxes from the acquisition. Yet, if an additional 400,000 shares of common stock were sold, the dividend requirements, at the current rate of $2.00 a share, would be only $800,000 a year. Since management was not considering raising the dividend rate, she could not see how the sale of the common stock would hurt the interests of present stockholders, Further, if there were any immediate sacrifice by existing shareholders, she argued that it would be overcome as expansion of the firm continued. Under these circumstances, she argued that the bond issue should be rejected, given the cash demands it would place on the firm.

On the other hand, one director became very agitated in arguing that the stock was a "steal" at $26.50 a share. He pointed out the Central's policy of retaining earnings had built the book value of the firm to $45.00 a share as of December 1972. In addition, he felt that the true value of the company was understated, since book value of Central's assets was considerably below current replacement cost. This director was also worried by the substantial dilution of management's voting control of Central that was implicit in the 400,000 share offering. Thus, he concluded that the sale of common stock at this time would be a "gift" to new shareholders of the substantial value held by current stockholders.

Two directors agreed that the sale of stock would dilute the stock's value, but they measured this dilution in terms of earnings per share instead of book or replacement value. These directors anticipated that postacquisition earnings would equal $6,800,000 before interest and taxes. If common stock were sold, earnings per share would be diluted to $2.62. In contrast, the directors argued that the sole use of debt would increase earnings per share to $3.33. The two directors felt that it was not important that the sinking fund equaled $.56 a share each year.

Finally, a director spoke about some personal observations he had made about financing in the trucking industry. First, he noted that Central was one of the few major common carriers that had no long-term debt in their capital structures, while Central's price-earnings ratio was among the lowest in the industry. Second he wondered whether Ms. Thorp had given consideration to the possibility of issuing preferred stock. This director had determined that Central could sell 100,000 shares of preferred stock bearing a dividend rate of $8.25 and a par value of $100. The director criticized Ms. Thorp for failing to deal with the issues he had raised.

This debate had caused the directors' meeting to run over its scheduled conclusion and no signs of agreement had developed. Ms. Thorp asked that the discussion of financing alternatives be held over until the June meeting to allow her time to prepare additional material. Now, as the date for the meeting approached, Ms. Thorp once again turned her attention to the issues raised at the board meeting. She realized that a considerable number of issues raised by the directors needed to be considered, and she designed a chart to aid in the comparison of the debt and stock alternatives (shown as Exhibit 3).

Exhibit 1

## CENTRAL EXPRESS CORPORATION

### Selected Income and Dividend Data, 1967-1973
(In thousands except per share data)

| | Operating Revenue | Income before Taxes | Income after Taxes | Income per Share | Dividends per Share | Market Prices per Share of Common Stock High | Market Prices per Share of Common Stock Low |
|---|---|---|---|---|---|---|---|
| 1967 | $126,000 | $2,898 | $1,449 | $1.61 | $1.00 | 19 1/4 | 11 1/4 |
| 1968 | 138,750 | 3,330 | 1,665 | 1.85 | 1.20 | 24 | 14 3/4 |
| 1969 | 147,461 | 3,834 | 1,917 | 2.13 | 1.20 | 25 1/2 | 15 |
| 1970 | 171,692 | 4,464 | 2,232 | 2.48 | 1.20 | 27 1/4 | 17 3/8 |
| 1971 | 185,333 | 5,004 | 2,502 | 2.78 | 2.00 | 38 3/4 | 22 1/4 |
| 1972 | 205,714 | 5,760 | 2,880 | 3.20 | 2.00 | 34 | 25 1/2 |
| 1973 Est.* | 216,000 | 5,120 | 2,560 | 2.85 | 2.00** | 28 3/4*** | 23 1/2*** |

*Excluding the proposed acquisition and its financing.

**Annual rate.

***To May 1 (May 1 prices were 28 3/8 - 28 1/8).

Exhibit 2

## CENTRAL EXPRESS CORPORATION

### Summary Balance Sheet as of December 31, 1972
(In thousands)

| | | |
|---|---|---|
| ASSETS | | |
| Cash | $ 3,800 | |
| Accounts receivable | 7,690 | |
| Inventory | 1,620 | |
| Pre-paid expenses | 1,820 | |
| Current assets | | $14,930 |
| Carrier operating property (cost) | 47,330 | |
| Less: Accumulated depreciation | 17,820 | |
| Net carrier operating property | | 29,510 |
| Other assets | | 6,180 |
| Total assets | | $50,620 |
| LIABILITIES AND STOCKHOLDERS' EQUITY | | |
| Accounts payable | $ 5,060 | |
| Miscellaneous payables and accruals | 4,050 | |
| Taxes payable | 1,010 | |
| Current liabilities | | $10,120 |
| Common stock ($1 par) | 900 | |
| Paid-in surplus | 8,000 | |
| Retained earnings | 31,000 | |
| Stockholders' equity | | 40,500 |
| Total liabilities and stockholders' equity | | $50,620 |

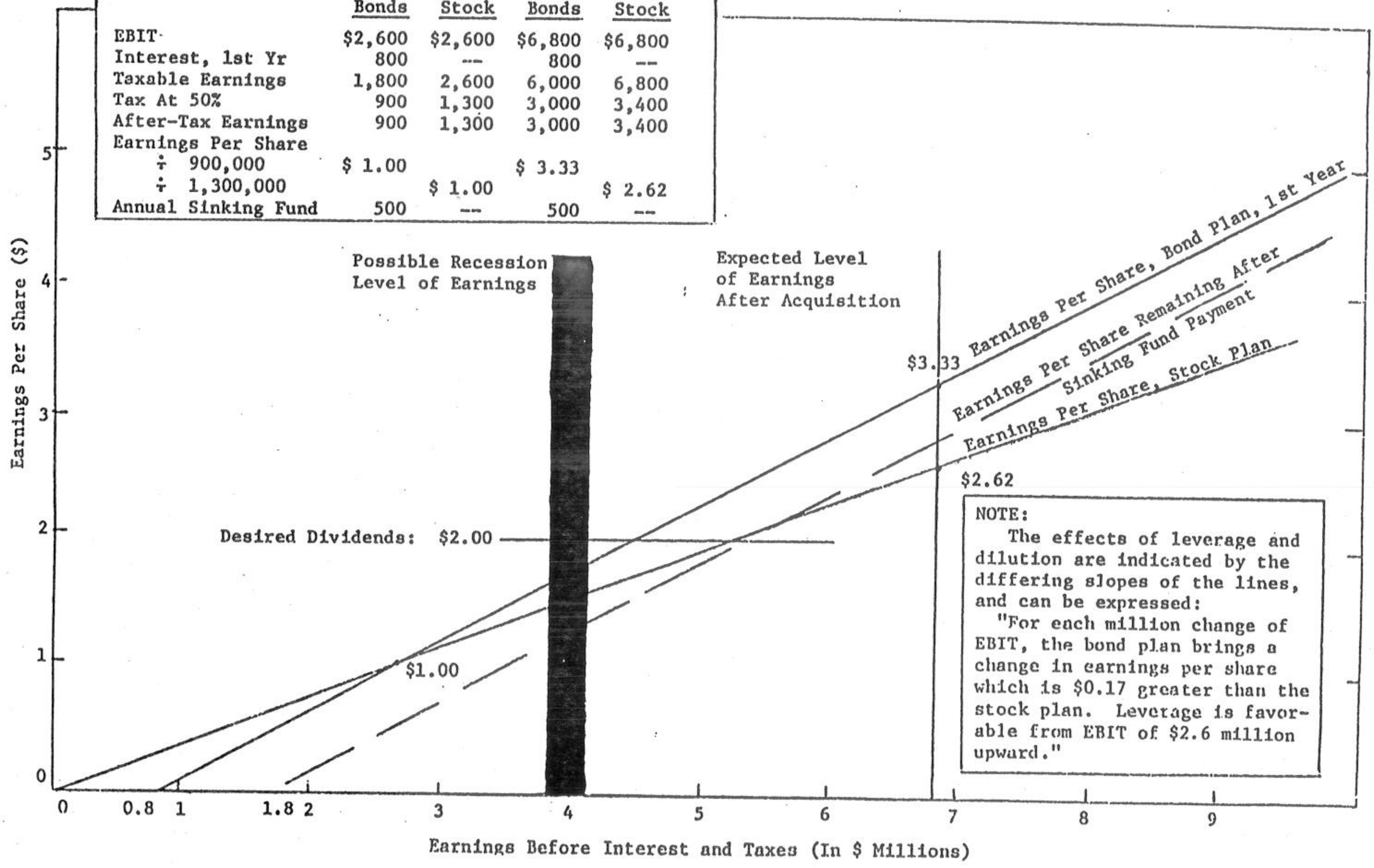
Exhibit 3

## CENTRAL EXPRESS CORPORATION

### Analysis of Financial Alternatives

**Calculation of Points To Determine Lines** (In thousands except data per share)

| | Bonds | Stock | Bonds | Stock |
|---|---|---|---|---|
| EBIT | $2,600 | $2,600 | $6,800 | $6,800 |
| Interest, 1st Yr | 800 | --- | 800 | -- |
| Taxable Earnings | 1,800 | 2,600 | 6,000 | 6,800 |
| Tax At 50% | 900 | 1,300 | 3,000 | 3,400 |
| After-Tax Earnings | 900 | 1,300 | 3,000 | 3,400 |
| Earnings Per Share | | | | |
| ÷ 900,000 | $ 1.00 | | $ 3.33 | |
| ÷ 1,300,000 | | $ 1.00 | | $ 2.62 |
| Annual Sinking Fund | 500 | -- | 500 | -- |



NOTE:

The effects of leverage and dilution are indicated by the differing slopes of the lines, and can be expressed:

"For each million change of EBIT, the bond plan brings a change in earnings per share which is $0.17 greater than the stock plan. Leverage is favorable from EBIT of $2.6 million upward."

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WHARTON REPROGRAPHICS

# Assignments

ASSIGNMENT #1

sheet

1. ~~B & M, Read Ch.3~~, Questions 6,9,10,15 (~~Please be sure to read Chapters 1 & 2~~)

2. ~~B & M, Read Ch.5~~, Questions 1,3,4,7,8,~~10~~ ab

3. A lender has been asked to make the following mortgage loan:

   $100,000 - Loan Amount
   12%/30 year amortization for the first five years, increasing to 13%/25 year amortization for the next five years. The balance is due 10 years from today (balloon payment). Assume annual payments for simplicity.

   How many points should the lender charge today in order for the overall yield to be 13.5% over the 10 year holding period?

4. A woman, age 40, is planning her retirement pension. She will retire at age 65, and wishes to receive annual retirement benefits of $20,000 per year until the age of 80. If she plans to increase her annual pension contributions by 3 percent per year, what must her first contribution be? (Assume a constant interest rate of 10%, and ignore inflation.)

Assignment #3

1. B&M - Ch. 4, Ouestions 5, 7, 8, 13, 15
Ch. 21, Questions 2 (parts a, b, and c), 3

2. Suppose we observe prices for a one-year and two-year U.S. Government note each with a 14 percent coupon and $1,000 face value. The prices and cash payoffs to the two notes are shown below (annual coupons assumed for simplicity).

| | Price | $C_1$ | $C_2$ |
|---|---|---|---|
| One-year | 950 | 1140 | ---- |
| Two-year note | 1000 | 140 | 1140 |

a. What is the yield to maturity of the one-year note? (Ignore taxes.)

b. What is the yield to maturity of the two-year note? (Ignore taxes.)

c. Suppose there is a government bond with a 5 percent coupon with two years remaining until maturity, (i.e., $C_1 = 50$, $C_2 = 1050$). What is the bond's price today? Ignore taxes in answering part (c).

## Assignment #4

1. B & M, Ch. 17, Question 1.

2. One Mile Island Power Co. is an electric utility planning to build a new power generating plant of conventional design. The company has traditionally paid out all earnings to the stockholders as dividends and financed capital expenditures with new issues of common stock. There is no debt or preferred stock presently outstanding. Data on the company and the new power plant are shown below. Assume all earnings are expected to be level perpetuities.

| Company data | Power Plant |
|---|---|
| Earnings: $30 million | Initial outlay: $20 million |
| Number of outstanding shares: 1.0 million | Added annual earnings: $3 million |

Management estimates the rate of return required by stockholders to be ten percent per year and considers the power plant to have the same risk as existing assets.

a. Assuming no taxes, no costs to bankruptcy, and perfect capital markets, what will be the total market value of One Mile Island if common stock is issued to finance the plant?

b. How many new shares must be issued to finance the plant and at what price?

c. Under the MM assumptions, if $20 million of bonds bearing 6% interest are issued to finance the plant, what happens to the required rate of return on the firm's equity? What happens to the price of its stock?

Assignment #6

1. B & M, Ch. 18, Questions 12.

2. Refer back to the "One Mile Island" problem (Assign. #4, Q.2)

    d. Reanswer parts (a) and (b) assuming a 40% corporate tax rate and no personal taxes. Assume that the "corrected MM theory" holds.

    e. Under the assumptions of part d, what would happen to the price of the firm's stock if $20 million of 6% bonds are used to finance the plant?

    f. What would happen to the required rate of return on equity capital?

Assignment #7

1. B & M, Ch. 19, Questions 1, 4.

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WHARTON REPROGRAPHICS

# ANSWERS

2. B&M, Ch. 21

(Q.2)

a. $DF_1 = \frac{1}{1.05} = 0.952$ $\quad$ $DF_4 = \frac{1}{(1.059)^4} = 0.795$

$DF_2 = \frac{1}{(1.054)^2} = 0.900$ $\quad$ $DF_5 = \frac{1}{(1.06)^5} = 0.747$

$DF_3 = \frac{1}{(1.057)^3} = 0.847$

b. $_0f_1 = r_1 = 0.05$

$_1f_2 = \frac{1.054^2}{1.05} - 1 = 0.058$

$_2f_3 = \frac{1.057^3}{1.054^2} - 1 = 0.063$

$_3f_4 = \frac{1.059^4}{1.057^3} - 1 = 0.065$

$_4f_5 = \frac{1.06^5}{1.059^4} - 1 = 0.064$

c. Assume annual coupons and a face value of $1000.

i. PV = 50(0.952) + 1050(0.900) = $992.60

ii. PV = 50(.952) + 50(.900) + 50(.847) + 50(.795)
+ 1050(.747) = $959.05

iii. PV = 100(.952) = 100(.900) + 100(.847) + 100(.795)
+ 100(.747) = $1,171.10

(Q.3) A six year spot rate of 4.8% implies a negative forward rate:

$$\frac{1.048^6}{1.06^5} - 1 = -0.01$$

To make money on this , borrow \$1000 for six years at 4.8%, lend \$990 for five years at 6%, holding cash over the sixth year. This ensures that you have enough money to repay your loan, and you can pocket the \$10 difference today.

The minimum sensible rate is solved for by:

$$\frac{(1 + r_6)^6 - 1 = 0}{1.06^5}$$

$$r_6 = 4.976\%$$

2. a. $\text{YTM}_1 = \frac{1140}{950} - 1 = 0.20$

b. $\text{YTM}_2 = 0.14$; a coupon bond selling at par has a YTM equal to the coupon rate.

c. $$\text{PV} = \frac{50}{(1 + r_1)} + \frac{1050}{(1 + r_2)^2}$$

from (a), $r_1 = 0.20$

from (b), $$1000 = \frac{140}{(1 + r_1)} + \frac{1140}{(1 + r_2)^2} = \frac{140}{1.20} + \frac{1140}{(1 + r_2)^2}$$

$$r_2 = 13.6\%$$

$$\text{PV} = \frac{50}{1.20} + \frac{1050}{1.136^2} = \$855.30$$

## Assignment #6: Solutions

1. B&M, Ch. 18

(Q.12) a. Bond holders benefit from the protection of covenants when the firm is in financial distress.

b. Ex-ante, when the bonds are issued, equity holders benefit. This is because bondholders will charge for the expected COFD when they set the price of the bonds. Stockholders will accept any credible and low-cost way of reducing these COFD. Hence, we would expect them to issue the bond with the restrictive covenants.

2 (Refer also to "One Mile Island" problem.)

d. With corporate taxes (at T=40%), assuming the firm makes full use of its tax shields, we get the tax advantage to debt (a la MM). [Note: to keep things simple, I'm going to ignore depreciation tax shields and ITC on the new project; imagine that the present value of these items has been netted out against the initial investment so that the net investment is $20M.]

With stock issue to finance the project:

(i) EXISTING ASSETS

| | |
|---|---|
| $A = \frac{30(1-.4)}{.10} = 180$ | E = 180 |
| V = 180 | V = 180 |

(ii) ANNOUNCE PROJECT

| | |
|---|---|
| A = 180<br>$NPV = \frac{3(1-.4)}{.10} - 20$<br>$= -2$ | E = 178 (P=178 |
| V = 178 | V = 178 |

(iii) ISSUE STOCK

| | |
|---|---|
| A = 180<br>NPV = -2<br>CASH = 20 | E = 178 (P=$178)<br>NE = 20 |
| V = 198 | V = 198 |

(iv) INVEST IN PROJECT

| | |
|---|---|
| A = 180<br>NA = 18 | E = 178<br>NE = 20 |
| V = 198 | V = 198 |

Number of new shares issued $= \frac{20M}{178} = 112{,}360$.

e. With bonds instead of stock:

(ii) ANNOUNCE PROJECT WITH DEBT FINANCING

| | |
|---|---|
| A = 180<br>APV = NPV + PVTS<br>$= -2 + (.4)(20)$<br>$= 6$ | E = 186 (P=$186) |
| V = 186 | V =186 |

(iii) ISSUE BONDS

| | | |
|---|---|---|
| A = 180 | E = 186 | (P=$186) |
| APV = 6 | D = 20 | |
| CASH = 20 | | |
| V = 206 | V = 206 | |

(iv) INVEST

| | |
|---|---|
| A = 180 | E = 186 |
| NA = 26 | D = 20 |
| V = 206 | V = 206 |

f.

$$R_E = R_A + (1-T)\frac{D}{E}(R_A - R_D) = .10 + \frac{(1-.4)\ (20)}{186}(.10 - .06) = .1026$$

## Assignment #7: Solutions

1. B&M, Ch. 19

(Q.1) Base case NPV $= -1{,}000{,}000 + \frac{85{,}000}{0.10} = -150{,}000$

PV (tax shield on additional borrowing) $= 0.3 \times 40{,}000 = 12{,}000$.

APV $= -150{,}000 + 12{,}000 = -\$138{,}000$.

(Q.4)) Two points: first, the costs of debt and equity are not 8.5 and 19 percent. These figures assume the costs are paid every year, not just at issue. Second, the fact that Bunsen can finance the entire cost of the project with debt is irrelevant. The cost of capital should not depend on whether the immediate source of funds is available; what matters is the project's contribution to the firm's overall borrowing power.

Note that the project is expected to support debt in perpetuity. The fact that the first issue is for 20 years only is irrelevant.

Assume the project has the same business risk as the firm's other assets. Since it is a perpetuity, we can use the firm's weighted-average cost of capital (if we ignore issue costs).

$$r^* = (1 - T_c) r_D \frac{D}{V} + r_E \frac{E}{V}$$

$$= (1 - .5)(.07)(.4) + (.14)(.6) = .098$$

$$\text{NPV @ } r^* = .098 = -1{,}000{,}000 + \frac{130{,}000}{.098} = \$326{,}530$$

**This exceeds the transaction cost of either alternative, so we know the project is a good one.**

**What about financing? The issue costs are:**

| | | |
|---|---|---|
| **Stock issue:** | **.05(1,000,000)** | **= $50,000** |
| **Bond issue:** | **.015(1,000,000)** | **= $15,000** |

**Debt is clearly cheaper - project NPV net of issue costs is reduced to $326,530 - 15,000 = $311,520. However, if debt is used , the firm's debt ratio will be above target, and more equity will have to be raised later. If this can be done by retaining earnings, then there are no other issue costs to consider. If stock will have to be issued to regain the target debt ratio, an additional issue cost is incurred.**